# ENGINE CONTROLS (TROUBLESHOOTING)

## SYMPTOMS - ENGINE CONTROLS

### Important Preliminary Inspections Before Starting

Perform **Diagnostic System Check - Engine Controls** before using the symptom tables, and verify that all of the following are true:

- The powertrain control module (PCM) and malfunction indicator lamp (MIL) are operating correctly.
- There are no DTCs stored.
- The scan tool data is within the normal operating range, refer to **Scan Tool Data List** .
- Verify the customer concern and locate the correct symptom in the table of contents. Inspect the items indicated under that symptom.

### Visual/Physical Inspection

Several of the symptom procedures ask for a careful visual and physical inspection. This step is extremely important. The visual and physical inspection can lead to correcting a problem without further inspections, and can save valuable time. Ensure that:

- The PCM grounds are clean, tight, and in the proper location.
- The vacuum hoses are not split or kinked, and properly connected, as shown on the Vehicle Emission Control Information label. Inspect thoroughly for any type of leak or restriction.
- The mass air flow (MAF) sensor is properly installed. The arrows on the plastic portion of the sensor must point toward the engine.
- The air intake ducts are not collapsed or damaged.
- There are no leaks at the throttle body mounting area, the MAF sensor, or the intake manifold sealing surfaces.
- The ignition wires are not cracked, brittle, or carbon tracked.
- The engine harness wiring and terminals are properly connected and are not pinched or cut.

### Intermittent

**IMPORTANT: Inspect for improper installation of electrical components if an intermittent condition exists. Inspect for aftermarket theft deterrent devices, lights, and cellular phones. Verify that no aftermarket equipment is connected to the class 2 circuit. If you can not locate an intermittent condition, a cellular phone communication signal may cause the condition.**

**IMPORTANT: The problem may or may not turn ON the malfunction indicator lamp (MIL) or store a DTC.**

Faulty electrical connections or wiring cause most intermittent problems. Perform a careful visual and physical inspection of the suspect connectors for the following conditions:

- Improperly mated connector halves
- Terminals that are not seated
- Terminals that are damaged or improperly formed

Reform or replace connector terminals in the problem circuit in order to ensure proper contact tension. Refer to **Connector Repairs** in Wiring Systems. Remove the terminal from the connector body in order to inspect for poor terminal wire connection. Refer to **Testing for Intermittent Conditions and Poor Connections** in Wiring Systems.

Road test the vehicle with the DMM connected to the suspected circuit. An abnormal reading that occurs when the malfunction occurs is a good indication that there is a malfunction in the circuit being monitored.

Use a scan tool in order to help detect intermittent conditions. Useful features of the GM Techline scan tool include the following:

- Trigger the Snapshot feature in order to capture and store engine parameters when the malfunction occurs. Review this stored information in order to see the specific running conditions that caused the malfunction.
- Freeze Frame/Failure Records can also aid in locating an intermittent condition. Review and capture the information in the Freeze Frame/Failure Record associated with the intermittent DTC being diagnosed. Drive the vehicle within the conditions that were present when the DTC originally set.
- Use the Plot Function on the scan tool in order to plot selected data parameters. Review this stored information to aid in locating an intermittent problem. Refer to the scan tool Users Guide for more information.

**IMPORTANT: If the intermittent condition exists as a start and then stall, test for DTCs relating to the vehicle theft deterrent system. Test for improper installation of electrical options such as lights, cellular phones, etc.**

Any of the following may cause an intermittent malfunction indicator lamp (MIL) with no stored DTC:

- The ignition coils are shorted to a ground or arcing at the ignition wires or the spark plugs.
- The PCM grounds are loose or dirty. Refer to **Engine Controls Schematics** .
- The ignition control (IC) wires are routed too close to the secondary ignition wires, coils, or the generator. Ensure that all of the circuits from the PCM to the ignition coils have good connections.
- There is an open diode across the A/C compressor clutch or any other open diodes.

Use the following tables when diagnosing a symptom complaint:

- **Intermittent Conditions**
- **Hard Start**
- **Surges/Chuggles**
- **Lack of Power, Sluggishness, or Sponginess**
- **Detonation/Spark Knock**
- **Hesitation, Sag, Stumble**
- **Cuts Out, Misses**
- **Poor Fuel Economy**
- **Poor Fuel Fill Quality**
- **Rough, Unstable, or Incorrect Idle and Stalling**
- **Dieseling, Run-On**
- **Backfire**

## INTERMITTENT CONDITIONS

**Intermittent Conditions**

| Inspection/Test | Action |
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| DEFINITION: The problem is not currently present but is indicated in DTC History.<br>OR<br>There is a customer complaint, but the symptom can not currently be duplicated, if the problem is not DTC related. | |
| Preliminary | Refer to **Symptoms - Engine Controls** before starting. |
| Harness/Connector | Many intermittent open or shorted circuits are affected by harness/connector movement that is caused by vibration, engine torque, bumps/rough pavement, etc. Test for this type of condition by performing the applicable procedure from the following list:<br>• Move related connectors and wiring while monitoring the appropriate scan tool data.<br>• Move related connectors and wiring with the component commanded ON, and OFF, with the scan tool. Observe the component operation.<br>• With the engine running, move related connectors and wiring while monitoring engine operation.<br>If harness or connector movement affects the data displayed, component/system operation, or engine operation, inspect and repair the harness/connections as necessary.<br>Refer to Electrical Connections or Wiring. |
| Electrical Connections or Wiring | Poor electrical connections, terminal tension or wiring problems cause most intermittents. Refer to **Testing for Intermittent Conditions and Poor Connections** , **Circuit Testing** , **Connector Repairs** , or **Wiring Repairs** in |

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| | Wiring Systems to perform the following inspections:<br>• Inspect for poor mating of the connector halves, or terminals improperly seated in the connector body.<br>• Inspect for improperly formed or damaged terminals. Test for poor terminal tension.<br>• Inspect for poor terminal to wire connections including terminals crimped over insulation. This requires removing the terminal from the connector body.<br>• Inspect for corrosion/water intrusion. Pierced or damaged insulation can allow moisture to enter the wiring. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits.<br>• Inspect for wires that are broken inside the insulation.<br>• Inspect the harness for pinched, cut or rubbed through wiring.<br>• Ensure that the wiring does not come in contact with hot exhaust components. |
| Control Module Power and Grounds Component Power and Grounds | Poor power or ground connections can cause widely varying symptoms.<br>• Test all control module power supply circuits. Many vehicles have multiple circuits supplying power to the control module. Other components in the system may have separate power supply circuits that may also need to be tested. Inspect connections at the module/component connectors, fuses, and any intermediate connections between the power source and the module/component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Ensure that the circuit can carry the current necessary to operate the component. Refer to **Circuit Testing** and **Power Distribution Schematics** in Wiring Systems.<br>• Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point. Inspect the connections at the component and in splice packs, where applicable. Ensure that the circuit can carry the current necessary to operate the component. Refer to **Circuit Testing** and **Ground Distribution Schematics** in Wiring Systems. |
| Temperature Sensitivity | • An intermittent condition may occur when a component/connection reaches normal operating temperature. The condition may occur only when the component/connection is cold, or only when the component/connection is hot.<br>• Freeze Frame, Failure Records, Snapshot, or Vehicle Data Recorder data may help with this type of intermittent condition, where applicable.<br>• If the intermittent is related to heat, review the data for a relationship with |

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| | the following:<br>○ High ambient temperatures<br>○ Underhood/engine generated heat<br>○ Circuit generated heat due to a poor connection, or high electrical load<br>○ Higher than normal load conditions, towing, etc.<br>• If the intermittent is related to cold, review the data for the following:<br>○ Low ambient temperatures - In extremely low temperatures, ice may form in a connection or component. Test for water intrusion.<br>○ The condition only occurs on a cold start.<br>○ The condition goes away when the vehicle warms up.<br>• Information from the customer may help to determine if the trouble follows a pattern that is temperature related. |
| Electromagnetic Interference (EMI) and Electrical Noise | Some electrical components/circuits are sensitive to EMI or other types of electrical noise. Inspect for the following conditions:<br>• A misrouted harness that is too close to high voltage/high current devices such as secondary ignition components, motors, generator etc. These components may induce electrical noise on a circuit that could interfere with normal circuit operation.<br>• Electrical system interference caused by a malfunctioning relay, or a powertrain control module (PCM) driven solenoid or switch. These conditions can cause a sharp electrical surge. Normally, the problem will occur when the malfunctioning component is operating.<br>• Improper installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc. These accessories may lead to an emission related OBD II failure while in use, but do not fail when the accessories are not in use. Refer to **Checking Aftermarket Accessories** in Wiring Systems.<br>• Test for an open diode across the A/C compressor clutch and for other open diodes. Some relays may contain a clamping diode.<br>• Test the generator for a bad rectifier bridge that may be allowing AC noise into the electrical system. Refer to **Diagnostic System Check - Engine Electrical** in Engine Electrical. |
| Incorrect PCM Programming | • There are only a few situations where reprogramming a PCM is appropriate:<br>○ A new service PCM is installed.<br>○ A PCM from another vehicle is installed.<br>○ Revised software/calibration files have been released for this vehicle.<br>**IMPORTANT:**<br>**DO NOT re-program the PCM with the SAME software/calibration files** |

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| | **that are already present in the PCM. This is not an effective repair for any type of driveability problem.**<br><br>• Verify that the PCM contains the correct software/calibration. If incorrect programming is found, reprogram the PCM with the most current software/calibration. Refer to **Service Programming System (SPS)** in Programming. |
| Duplicating Failure Conditions | • If none of the previous tests are successful, attempt to duplicate and/or capture the failure conditions.<br>• Freeze Frame/Failure Records data, where applicable, contains the conditions that were present when the DTC set.<br>1. Review and record Freeze Frame/Failure Records data<br>2. Clear the DTCs using the scan tool.<br>3. Turn the key to OFF and wait 15 seconds.<br>4. Operate the vehicle under the same conditions that were noted in Freeze Frame/Failure Records data, as closely as possible. The vehicle must also be operating within the Conditions for Running the DTC. Refer to Conditions for Running the DTC in the supporting text of the DTC being diagnosed.<br>5. Monitor DTC Status for the DTC being tested. The scan tool will indicate Ran, when the enabling conditions have been satisfied long enough for the DTC to run. The scan tool will also indicate whether the DTC passed or failed.<br>• An alternate method is to drive the vehicle with the DMM connected to a suspected circuit. An abnormal reading on the DMM when the problem occurs, may help you locate the problem. |
| Scan Tool Snapshot | The scan tool can be set up to take a Snapshot of the parameters available via serial data. The Snapshot function records live data over a period of time. The recorded data can be played back and analyzed. The scan tool can also graph parameters singly or in combinations of parameters for comparison. The Snapshot can be triggered manually at the time the symptom is noticed, or set up in advance to trigger when a DTC sets.<br>An abnormal value captured in the recorded data may point to a system or component that needs to be investigated further.<br>Refer to the scan tool user instructions for more information on the Snapshot function. |
| Vehicle Data Recorder | The **J 42598** Vehicle Data Recorder is connected to the data link connector (DLC) and sent with the customer. The **J 42598** captures data for later retrieval and analysis by the technician. Refer to the vehicle data recorder user instructions for more information. |

## HARD START

### Hard Start

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| Inspection/Test | Action |
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| DEFINITION: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies. | |
| Preliminary | • Refer to Important Preliminary Inspections Before Starting in **Symptoms - Engine Controls** .<br>• Verify that the powertrain control module (PCM) grounds are clean, tight, and in the proper locations. Refer to **Power and Grounding Component Views** in Wiring Systems, and **Engine Controls Schematics** .<br>• Search for bulletins. |
| Sensor/System | • Verify that the engine coolant temperature (ECT) sensor is not shifted in value. Connect a scan tool. Compare the engine coolant temperature to the intake air temperature (IAT) on a cold engine. The ECT and IAT sensor values should be within +/- 3°C (5°F) of each other. If the ECT sensor is out of range with the IAT sensor, measure the resistance of the ECT sensor. Refer to **Temperature vs Resistance** for resistance specifications.<br>**IMPORTANT:**<br>**The embossed arrows on the MAF sensor indicate the direction of the intake air flow. The arrows must point toward the engine.**<br>• Inspect the mass air flow (MAF) sensor installation. A MAF sensor that is incorrectly installed may cause a hard start. Install the MAF in the proper direction. Refer to **Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor Replacement** .<br>• Inspect the camshaft position (CMP) sensor for proper mounting and/or a bad connection. An extended crank occurs if the PCM does not receive a CMP signal. |
| Fuel System | • Inspect the fuel pump relay operation. The fuel pump should turn ON for 2 seconds when you turn ON the ignition. Refer to **Fuel Pump Electrical Circuit Diagnosis** .<br>• Verify that both fuel injector fuses are not open. An open fuel injector fuse causes 4 injectors and 4 ignition coils not to operate. Inspect the injector circuits and the ignition coil circuits for an intermittent short to ground. Replace the fuse. Refer to **Circuit Testing** in Wiring Systems.<br>• Inspect for incorrect fuel pressure. Refer to **Fuel System Diagnosis** .<br>• Inspect for a contaminated fuel condition. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** . |
| Ignition System | • Verify that both fuel injector fuses are not open. An open fuel injector fuse causes 4 ignition coils and 4 fuel injectors not to operate. Inspect the ignition coil circuits and the fuel injector circuits for an intermittent short to ground. Refer to **Circuit Testing** in Wiring Systems. Replace the fuse.<br>• Inspect for proper ignition voltage output with the **J 26792** Spark Tester. Refer to |

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| | **Electronic Ignition (EI) System Diagnosis** .<br>• Remove the spark plugs and inspect for the following:<br>  ○ Correct heat range<br>  ○ Wet plugs<br>  ○ Cracks<br>  ○ Wear<br>  ○ Improper gap<br>  ○ Burned electrodes<br>  ○ Heavy deposits<br><br>Refer to **Spark Plug Inspection** .<br><br>• Determine the cause of the conditions before replacing the spark plugs.<br>• Inspect for bare or shorted ignition wires. Refer to **Spark Plug Wire Inspection** .<br>• Inspect for loose ignition coil grounds. Refer to **Electronic Ignition (EI) System Diagnosis** . |
| Engine Mechanical | Inspect for the following conditions:<br><br>• Excessive oil in combustion chamber or leaking valve seals - Refer to **Oil Consumption Diagnosis** in Engine Mechanical.<br>• Low cylinder compression - Refer to **Engine Compression Test** in Engine Mechanical.<br>• Combustion chambers for excessive carbon buildup - Clean the chambers using top engine cleaner. Follow the instructions on the can.<br>• Incorrect basic engine parts - Inspect the following:<br>  ○ Cylinder heads - Refer to **Cylinder Head Cleaning and Inspection** in Engine Mechanical.<br>  ○ Camshaft - Refer to **Camshaft and Bearings Cleaning and Inspection** in Engine Mechanical.<br>  ○ Pistons, etc. - Refer to **Piston, Connecting Rod, and Bearings Cleaning and Inspection** in Engine Mechanical.<br>• Inspect for excessive crankshaft endplay that will cause the crankshaft position (CKP) sensor reluctor wheel to move out of alignment with the CKP sensor. Refer to **Crankshaft and Bearings Cleaning and Inspection** in Engine Mechanical. This could result in any of the following conditions:<br>  ○ A no start<br>  ○ A start and stall<br>  ○ Erratic performance |

**SURGES/CHUGGLES**

**Surges/Chuggles**

| Inspection/Tests | Action |
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| DEFINITION: Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position. | |
| Preliminary | • Refer to Important Preliminary Inspections Before Starting in **Symptoms - Engine Controls** .<br>• Search for bulletins.<br>• Inspect the powertrain control module (PCM) grounds for being clean, tight, and in the proper locations. Refer to **Power and Grounding Component Views** in Wiring Systems and **Engine Controls Schematics** .<br>• Verify the driver understands the operation of the transmission torque converter clutch (TCC) and A/C compressor operation as explained in the owners manual. Inform the customer how the TCC and the A/C clutch operates. |
| Sensor/System | • Inspect the heated oxygen sensors (HO2S). The HO2S should respond quickly to different throttle positions. If they do not, inspect the HO2S for silicon or other contaminates from fuel or the use of improper RTV sealant. The sensors may have a white, powdery coating and result in a high but false signal voltage rich exhaust indication. The PCM will then reduce the amount of fuel delivered to the engine causing a severe driveability problem.<br>• Inspect the mass air flow (MAF) sensor connections. Repair or replace damaged terminals. Refer to **Connector Repairs** in Wiring Systems. |
| Fuel System | • Test for incorrect fuel pressure. Refer to **Fuel System Diagnosis** .<br>• Inspect for a contaminated fuel condition. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>• Verify that each injector harness is connected to the correct injector or cylinder. Relocate injector harnesses as necessary.<br>• Inspect for the following that may cause the engine to run rich:<br>**NOTE:**<br>**Refer to Heated Oxygen and Oxygen Sensor Notice in Cautions and Notices.**<br>o Water intrusion in the HO2S connector<br>o Engine oil contaminated by fuel<br>o An evaporative emission (EVAP) canister purge condition<br>o Incorrect fuel pressure - Refer to **Fuel System Diagnosis** .<br>o Leaking fuel injectors - Refer to **Fuel System Diagnosis** .<br>o An inaccurate MAF sensor<br>o Blockage on the inlet screen of the MAF sensor - Refer to **Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor Replacement** .<br>o Vacuum hoses that are split, kinked, or improperly connected |

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| | ○ An air intake duct that is collapsed or restricted - Refer **Air Cleaner Resonator Outlet Duct Replacement** .<br>○ An air filter that is dirty or restricted-Refer to **Air Cleaner Element Replacement** .<br>• Inspect for the following conditions that may cause the engine to run lean:<br>**NOTE:**<br>**Refer to Heated Oxygen and Oxygen Sensor Notice in Cautions and Notices.**<br>○ Water intrusion in the HO2S connector<br>○ An exhaust leak between the HO2S and the engine - Refer to **Exhaust Leakage** in Engine Exhaust.<br>○ Vacuum leaks<br>○ Incorrect fuel pressure - Refer to **Fuel System Diagnosis** .<br>○ Restricted fuel injectors - Refer to **Fuel Injector Balance Test with Special Tool** or **Fuel Injector Balance Test with Tech 2** .<br>○ An inaccurate MAF sensor<br>○ Fuel contamination - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>○ Vacuum hoses that are split, kinked, or improperly connected |
| Ignition System | • Soak the secondary ignition system with water from a spray bottle. Soaking the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water.<br>• Test for proper ignition voltage output with the **J 26792** Spark Tester. Refer to **Electronic Ignition (EI) System Diagnosis** .<br>• Remove the spark plugs and inspect for the following:<br>○ Correct heat range<br>○ Wet plugs<br>○ Cracks<br>○ Wear<br>○ Improper gap<br>○ Burned electrodes<br>○ Heavy deposits<br>Refer to **Spark Plug Inspection** .<br>• An improper spark plug gap will cause a driveability problem. Gap the spark plugs using a wire gauge gap tool. Refer to **Spark Plug Replacement** .<br>• Determine the cause of the fouling before replacing the spark plugs. |

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| | • Monitor the Misfire Current Counters while driving the vehicle within the conditions that the misfire occurred. If a misfiring cylinder can be located, use the DTC P0300 table for diagnosis. Refer to **DTC P0300** .<br>• Inspect for loose ignition coil grounds. Refer to **Electronic Ignition (EI) System Diagnosis** . |
| Engine Mechanical | • Verify that the engine coolant temperature (ECT) is not above 130°C (266°F). This condition causes the PCM to operate in Engine Coolant Over Temperature-Fuel Disabled Mode. While in Engine Coolant Over Temperature-Fuel Disabled Mode, the PCM turns fuel OFF to 4 cylinders at a time to keep engine temperatures from reaching damaging levels. The driver may perceive Engine Coolant Over Temperature-Fuel Disabled Mode as a lack of power, miss, or rough idle. If the vehicle operates in Engine Coolant Over Temperature-Fuel Disabled Mode, refer to **Engine Overheating** in Engine Cooling for diagnosis.<br>• Inspect for excessive crankshaft endplay that will cause the crankshaft position (CKP) sensor reluctor wheel to move out of alignment with the CKP sensor. Refer to **Crankshaft and Bearings Cleaning and Inspection** in Engine Mechanical. This could result in any of the following conditions:<br>o A no start<br>o A start and stall<br>o Erratic performance |
| Additional Inspections | • Visually and physically inspect vacuum hoses for splits, kinks, and proper connections and routing as shown on the Vehicle Emission Control Information label.<br>• Inspect the transmission torque converter clutch (TCC) operation. A TCC applying too soon can cause the engine to spark knock. Refer to **Diagnostic Starting Point - Automatic Transmission** in Automatic Transmission - 4L60-E. |

## LACK OF POWER, SLUGGISHNESS, OR SPONGINESS

**Lack of Power, Sluggishness, or Sponginess**

| Inspection/Tests | Action |
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| DEFINITION: Engine delivers less than expected power. Little or no increase in speed when the accelerator pedal is pushed down part way. | |
| Preliminary Inspections | • Refer to Important Preliminary Inspections Before Starting in **Symptoms - Engine Controls** .<br>• Search for bulletins.<br>• Verify that the powertrain control module (PCM) grounds are clean, tight, and in the proper locations. Refer to **Power and Grounding Component Views** in Wiring Systems and **Engine Controls Schematics** .<br>• Remove the air filter element and inspect for dirt or for restrictions. Refer to **Air Cleaner Element Replacement** and replace as necessary. |
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| Fuel System | • Inspect both injector fuses for being open. An open injector fuse causes 4 ignition coils and 4 injectors not to operate. Replace the fuse. Inspect the ignition coil circuits and the injector circuits for an intermittent short to ground.<br>• Inspect for incorrect fuel pressure. Refer to **Fuel System Diagnosis** .<br>• Inspect for a contaminated fuel condition. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>• Inspect the fuel injectors. Refer to **Fuel Injector Coil Test** .<br>• Inspect for the following that may cause the engine to run rich:<br>**NOTE:**<br>**Refer to Heated Oxygen and Oxygen Sensor Notice in Cautions and Notices.**<br>o Water intrusion in the heated oxygen sensor (HO2S) connector<br>o Engine oil contaminated by fuel<br>o An evaporative emission (EVAP) canister purge condition<br>o Incorrect fuel pressure - Refer to **Fuel System Diagnosis** .<br>o Leaking fuel injectors - Refer to **Fuel System Diagnosis** .<br>o An inaccurate mass air flow (MAF) sensor<br>o Blockage on the inlet screen of the MAF sensor - Refer to **Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor Replacement** .<br>o Vacuum hoses that are split, kinked, or improperly connected<br>o An air intake duct that is collapsed or restricted - Refer to **Air Cleaner Resonator Outlet Duct Replacement** .<br>o An air filter that is dirty or restricted - Refer to **Air Cleaner Element Replacement** .<br>• Inspect for the following conditions that may cause the engine to run lean:<br>**NOTE:**<br>**Refer to Heated Oxygen and Oxygen Sensor Notice in Cautions and Notices.**<br>o Water intrusion in the HO2S connector<br>o An exhaust leak between the HO2S and the engine - Refer to **Exhaust Leakage** in Engine Exhaust.<br>o Vacuum leaks<br>o Incorrect fuel pressure - Refer to **Fuel System Diagnosis** .<br>o Restricted fuel injectors - Refer to **Fuel Injector Balance Test with Special Tool** or **Fuel Injector Balance Test with Tech 2** .<br>o An inaccurate MAF sensor |

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| | ○ Fuel contamination - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>○ Vacuum hoses that are split, kinked, or improperly connected |
| Sensor/System | Use a scan tool in order to monitor the knock sensor (KS) system for excessive spark retard activity. Refer to **Knock Sensor (KS) System Description** . |
| Ignition System | • Verify that both fuel injector fuses are not open. An open fuel injector fuse causes 4 ignition coils and 4 fuel injectors not to operate. Inspect the ignition coil circuit and the injector circuits for an intermittent short to ground. Refer to **Circuit Testing** in Wiring Systems. Replace the fuse.<br>• Soak the secondary ignition system with water from a spray bottle. Soaking the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as water is applied.<br>• Inspect for proper ignition voltage output with the **J 26792** Spark Tester.<br>• Remove the spark plugs and inspect for the following:<br>○ Correct heat range<br>○ Wet plugs<br>○ Cracks<br>○ Wear<br>○ Improper gap<br>○ Burned electrodes<br>○ Heavy deposits<br><br>Refer to **Spark Plug Inspection** .<br><br>• An improper spark plug gap will cause a driveability problem. Gap the spark plugs using a wire gauge gap tool. Refer to **Spark Plug Replacement** .<br>• Determine the cause of the fouling before replacing the spark plugs.<br>• Monitor the Misfire Current Counters while driving the vehicle within the conditions that the misfire occurred. If a misfiring cylinder can be located with a misfire, use the DTC P0300 table for diagnosis. Refer to **DTC P0300** .<br>• Inspect for loose ignition coil grounds. Refer to **Electronic Ignition (EI) System Diagnosis** . |
| Engine Mechanical | • Verify that the engine coolant temperature (ECT) is not above 130°C (266°F). This condition causes the PCM to operate in Engine Coolant Over Temperature-Fuel Disabled Mode. While in Engine Coolant Over Temperature-Fuel Disabled Mode, the PCM will disable the fuel injectors to 4 cylinders at a time to keep engine temperatures from reaching damaging levels. The driver may perceive the Engine Coolant Over Temperature-Fuel Disabled Mode as a lack of power, miss, or rough idle. If the vehicle operates in Engine Coolant Over Temperature-Fuel Disabled Mode, refer to **Engine Overheating** in Engine Cooling for diagnosis. |

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| | • Inspect for excessive oil in the combustion chambers and leaking valve seals. Refer to **Oil Consumption Diagnosis** in Engine Mechanical.<br>• Test for low cylinder compression. Refer to **Engine Compression Test** in Engine Mechanical.<br>• Inspect for incorrect basic engine parts, including the following:<br>  ○ The camshaft - Refer to **Camshaft and Bearings Cleaning and Inspection** in Engine Mechanical.<br>  ○ The cylinder heads - Refer to **Cylinder Head Cleaning and Inspection** in Engine Mechanical.<br>  ○ The pistons, etc. - Refer to **Piston, Connecting Rod, and Bearings Cleaning and Inspection** in Engine Mechanical.<br>• Inspect for excessive crankshaft endplay that will cause the crankshaft position (CKP) sensor reluctor wheel to move out of alignment with the CKP sensor. Refer to **Crankshaft and Bearings Cleaning and Inspection** in Engine Mechanical. This could result in any of the following conditions:<br>  ○ A no start<br>  ○ A start and stall<br>  ○ Erratic performance |
| Additional Inspections | • Inspect the exhaust system for possible restrictions. Perform the following:<br>  ○ Inspect the exhaust system for damaged or collapsed pipes.<br>  ○ Inspect the mufflers for heat distress or internal failure.<br>  ○ Inspect for plugged catalytic converters. Refer to **Restricted Exhaust** in Engine Exhaust.<br>• Inspect the transmission torque converter clutch (TCC) for proper operation. Refer to **Diagnostic Starting Point - Automatic Transmission** in Automatic Transmission - 4L60-E. |

**DETONATION/SPARK KNOCK**

**Detonation/Spark Knock**

| Inspection/Tests | Action |
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| DEFINITION: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening. | |
| Preliminary Inspections | • Refer to Important Preliminary Inspections Before Starting in **Symptoms - Engine Controls** .<br>• Search for bulletins.<br>• Verify that the powertrain control module (PCM) grounds are clean, tight, and in the proper locations. Refer to **Power and Grounding Component Views** in Wiring Systems and **Engine Controls Schematics** .<br>• If there are no engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vehicles minimum octane requirements. Road test |

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| | the vehicle and re-evaluate the vehicles performance. |
| Fuel System | • Inspect for incorrect fuel pressure. Refer to **Fuel System Diagnosis** .<br>• Inspect for a contaminated fuel condition. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>• Inspect for the following conditions that may cause the engine to run lean:<br>**NOTE:**<br>**Refer to Heated Oxygen and Oxygen Sensor Notice in Cautions and Notices.**<br>o Water intrusion in the heated oxygen sensor (HO2S) connector<br>o An exhaust leak between the HO2S and the engine - Refer to **Exhaust Leakage** in Engine Exhaust.<br>o Vacuum leaks<br>o Incorrect fuel pressure - Refer to **Fuel System Diagnosis** .<br>o Restricted fuel injectors - Refer to **Fuel Injector Balance Test with Special Tool** or **Fuel Injector Balance Test with Tech 2** .<br>o An inaccurate mass air flow (MAF) sensor<br>o Fuel contamination - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>o Vacuum hoses that are split, kinked, or improperly connected |
| Ignition System | Verify that the spark plugs are of the proper heat range. Refer to **Spark Plug Inspection** . |
| Engine Cooling System | Inspect for obvious overheating problems:<br>• Low engine coolant - Refer to **Loss of Coolant** in Engine Cooling for the type and amount of engine coolant to be used.<br>• Restricted air flow to the radiator or restricted coolant flow through the radiator.<br>• Inoperative cooling fan - Refer to **Fan Clutch Diagnosis** in Engine Cooling. |
| Engine Mechanical | Inspect for the following engine mechanical problems:<br>• Excessive oil in combustion chamber - Leaking valve seals. Refer to **Oil Consumption Diagnosis** in Engine Mechanical.<br>• Low cylinder compression - Refer to **Engine Compression Test** in Engine Mechanical.<br>• Combustion chambers for excessive carbon buildup - Clean the combustion chamber by using top engine cleaner. Follow the instructions on the can.<br>• Inspect for incorrect basic engine parts. Inspect the following:<br>o The camshaft - Refer to **Camshaft and Bearings Cleaning and** |

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| | **Inspection** in Engine Mechanical.<br>○ The cylinder heads - Refer to **Cylinder Head Cleaning and Inspection** in Engine Mechanical.<br>○ The pistons, etc. - Refer to **Piston, Connecting Rod, and Bearings Cleaning and Inspection** in Engine Mechanical.<br>• Refer to **Symptoms - Engine Mechanical** in Engine Mechanical. |
| Additional Inspections | • Inspect the park/neutral position (PNP) switch operation. Refer to **Diagnostic System Check - Automatic Transmission** in Automatic Transmission - 4L60-E.<br>• Inspect the transmission torque converter clutch (TCC) operation. The TCC applying too soon can cause the engine to spark knock. Refer to **Diagnostic System Check - Automatic Transmission** in Automatic Transmission - 4L60-E. |

**HESITATION, SAG, STUMBLE**

**Hesitation, Sag, Stumble**

| Inspection/Tests | Action |
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| DEFINITION: Momentary lack of response as the accelerator is pushed down. Can occur at any vehicle speed. Usually more pronounced when first trying to make the vehicle move, as from a stop. May cause the engine to stall if severe enough. | |
| Preliminary | • Refer to Important Preliminary Inspections Before Starting in **Symptoms - Engine Controls** .<br>• Search for bulletins.<br>• Verify that the powertrain control module (PCM) grounds are clean, tight, and in the proper locations. Refer to **Engine Controls Schematics** . |
| Sensor/System | Inspect the manifold absolute pressure (MAP) sensor operation. |
| Fuel System | • Inspect for incorrect fuel pressure. Refer to **Fuel System Diagnosis** .<br>• Inspect for a contaminated fuel condition. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>• Verify that both fuel injector fuses are not open. An open fuel injector fuse causes 4 ignition coils and 4 fuel injectors not to operate. Inspect the ignition coil circuits and the fuel injector circuits for an intermittent short to ground. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems. Replace the fuse.<br>• Inspect for the following that may cause the engine to run rich:<br>**NOTE:**<br>**Refer to Heated Oxygen and Oxygen Sensor Notice in Cautions and Notices.** |

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| | ○ Water intrusion in the heated oxygen sensor (HO2S) connector<br>○ Engine oil contaminated by fuel<br>○ An evaporative emission (EVAP) canister purge condition<br>○ Incorrect fuel pressure - Refer to **Fuel System Diagnosis** .<br>○ Leaking fuel injectors - Refer to **Fuel System Diagnosis** .<br>○ An inaccurate mass air flow (MAF) sensor<br>○ Blockage on the inlet screen of the MAF sensor - Refer to **Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor Replacement** .<br>○ Vacuum hoses that are split, kinked, or improperly connected<br>○ An air intake duct that is collapsed or restricted-Refer to **Air Cleaner Resonator Outlet Duct Replacement** .<br>○ An air filter that is dirty or restricted - Refer to **Air Cleaner Element Replacement** .<br>• Inspect for the following conditions that may cause the engine to run lean:<br>**NOTE:**<br>**Refer to Heated Oxygen and Oxygen Sensor Notice in Cautions and Notices.**<br>○ Water intrusion in the HO2S connector<br>○ An exhaust leak between the HO2S and the engine-Refer to **Exhaust Leakage** in Engine Exhaust.<br>○ Vacuum leaks<br>○ Incorrect fuel pressure - Refer to **Fuel System Diagnosis** .<br>○ Restricted fuel injectors - Refer to **Fuel Injector Balance Test with Special Tool** or **Fuel Injector Balance Test with Tech 2** .<br>○ An inaccurate MAF sensor<br>○ Fuel contamination - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>○ Vacuum hoses that are split, kinked, or improperly connected |
| Ignition System | • Soak the secondary ignition system with water from a spray bottle. Soaking the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply water.<br>• Test for proper ignition voltage output with the **J 26792** Spark Tester. Refer to **Electronic Ignition (EI) System Diagnosis** for the procedure.<br>• Remove the spark plugs and check for the following:<br>○ Correct heat range<br>○ Wet plugs<br>○ Cracks |

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| | ○ Wear<br>○ Improper gap<br>○ Burned electrodes<br>○ Heavy deposits<br><br>Refer to **Spark Plug Inspection** .<br><br>• An improper spark plug gap will cause a driveability problem. Gap the spark plugs using a wire gauge gap tool. Refer to **Spark Plug Replacement** .<br>• Determine the cause of the fouling before replacing the spark plugs.<br>• Monitor the Misfire Current Counters while driving the vehicle in the conditions that the misfire occurred. If a misfiring cylinder can be located, use the DTC P0300 table for diagnosis. Refer to **DTC P0300** .<br>• Inspect for loose ignition coil grounds. Refer to **Electronic Ignition (EI) System Diagnosis** . |
| Engine Cooling System | Inspect the engine thermostat for proper operation and for proper heat range. Refer to **Thermostat Diagnosis** in Engine Cooling. |
| Engine Mechanical | Inspect for excessive crankshaft endplay that will cause the crankshaft position (CKP) sensor reluctor wheel to move out of alignment with the CKP sensor. Refer to **Crankshaft and Bearings Cleaning and Inspection** in Engine Mechanical. This could result in any of the following conditions:<br><br>• A no start<br>• A start and stall<br>• Erratic performance |
| Additional Inspections | Inspect the generator output voltage. Refer to **Diagnostic System Check - Engine Electrical** in Engine Electrical for the procedure. Repair the charging system if the generator output voltage is less than 9 volts or more than 16 volts. |

**CUTS OUT, MISSES**

**Cuts Out, Misses**

| Inspections | Action |
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| DEFINITION: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. This condition is not normally felt above 1,500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or low speed. | |
| Preliminary | • Refer to Important Preliminary Inspections Before Starting in **Symptoms - Engine Controls** .<br>• Search for bulletins.<br>• Verify that the powertrain control module (PCM) grounds are clean, tight, and in the proper locations. Refer to **Power and Grounding Component Views** in Wiring Systems and **Engine Controls Schematics** . |

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| | • Remove the air filter element and inspect for dirt and for restrictions. Refer to **Air Cleaner Element Replacement** . Replace as necessary. |
| Fuel System | • Inspect the fuel injectors. Refer to **Fuel Injector Coil Test** .<br>• Inspect for incorrect fuel pressure. Refer to **Fuel System Diagnosis** .<br>• Inspect for a restricted fuel filter. Refer to **Fuel System Diagnosis** .<br>• Inspect for a contaminated fuel condition. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>• Inspect for the following that may cause the engine to run rich:<br>**NOTE:**<br>**Refer to Heated Oxygen and Oxygen Sensor Notice in Cautions and Notices.**<br>o Water intrusion in the heated oxygen sensor (HO2S) connector<br>o Engine oil contaminated by fuel<br>o An evaporative emission (EVAP) canister purge condition<br>o Incorrect fuel pressure - Refer to **Fuel System Diagnosis** .<br>o A leaking fuel pressure regulator - Refer to **Fuel System Diagnosis** .<br>o Leaking fuel injectors - Refer to **Fuel System Diagnosis** .<br>o An inaccurate mass air flow (MAF) sensor<br>o Blockage on the inlet screen of the MAF sensor - Refer to **Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor Replacement** .<br>o Vacuum hoses that are split, kinked, or improperly connected<br>o An air intake duct that is collapsed or restricted - Refer to **Air Cleaner Resonator Outlet Duct Replacement** .<br>o An air filter that is dirty or restricted - Refer to **Air Cleaner Element Replacement** .<br>• Inspect for the following conditions that may cause the engine to run lean:<br>**NOTE:**<br>**Refer to Heated Oxygen and Oxygen Sensor Notice in Cautions and Notices.**<br>o Water intrusion in the HO2S connector<br>o An exhaust leak between the HO2S and the engine - Refer to **Exhaust Leakage** in Engine Exhaust.<br>o Vacuum leaks<br>o Incorrect fuel pressure - Refer to **Fuel System Diagnosis** .<br>o Restricted fuel injectors - Refer to **Fuel Injector Balance Test with Special Tool** or **Fuel Injector Balance Test with Tech 2** . |

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| | ○ An inaccurate MAF sensor<br>○ Fuel contamination - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>○ Vacuum hoses that are split, kinked, or improperly connected |
| Sensor/System | Use a scan tool in order to monitor the knock sensor (KS) system for excessive spark retard activity. |
| Ignition System | • Soak the secondary ignition system with water from a spray bottle. Soaking the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply water.<br>• Test for proper ignition voltage output with the **J 26792** Spark Tester.<br>• Remove the spark plugs and inspect for the following:<br>○ Correct heat range<br>○ Wet plugs<br>○ Cracks<br>○ Wear<br>○ Improper gap<br>○ Burned electrodes<br>○ Heavy deposits<br><br>Refer to **Spark Plug Inspection** .<br><br>• An improper spark plug gap will cause a driveability problem. Refer to **Spark Plug Inspection** . Gap the spark plugs using a wire gauge gap tool. Refer to **Spark Plug Replacement** .<br>• Determine the cause of the fouling before replacing the spark plugs.<br>• Visually and physically inspect the secondary ignition for the following:<br>○ The ignition wires arcing to ground<br>○ The ignition wires for proper engagement to spark plug<br>○ The ignition coils for cracks or carbon tracking<br>• Monitor the Misfire Current Counters while driving the vehicle in the conditions that the misfire occurred. If a misfiring cylinder can be located, use the DTC P0300 table for diagnosis. Refer to **DTC P0300** . |
| Engine Mechanical | • Inspect engine mechanical for the following:<br>○ Inspect compression - Refer to **Engine Compression Test** in Engine Mechanical.<br>○ Sticking or leaking valves<br>○ Worn camshaft lobes<br>○ Valve timing<br>○ Bent push rods |

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| | ○ Worn rocker arms<br>○ Broken valve springs<br>○ Excessive oil in combustion chamber-Leaking valve seals. Refer to **Oil Consumption Diagnosis** in Engine Mechanical.<br>• For incorrect basic engine parts inspect the following:<br>○ The camshaft - Refer to **Camshaft and Bearings Cleaning and Inspection** in Engine Mechanical.<br>○ The cylinder heads - Refer to **Cylinder Head Cleaning and Inspection** in Engine Mechanical.<br>○ The pistons, etc.-Refer to **Piston, Connecting Rod, and Bearings Cleaning and Inspection** in Engine Mechanical.<br>• Inspect for excessive crankshaft endplay that will cause the crankshaft position (CKP) sensor reluctor wheel to move out of alignment with the CKP sensor. Refer to **Crankshaft and Bearings Cleaning and Inspection** in Engine Mechanical. This could result in any of the following conditions:<br>○ A no start<br>○ A start and stall<br>○ Erratic performance<br><br>Refer to **Symptoms - Engine Mechanical** in Engine Mechanical for diagnostic procedures. |
| Additional Inspections | • Inspect the exhaust system for possible restrictions. Inspect for the following:<br>○ Inspect the exhaust system for damaged or collapsed pipes.<br>○ Inspect the mufflers for heat distress or possible internal failure.<br>○ Inspect for possible plugged catalytic converters. Refer to **Restricted Exhaust** in Engine Exhaust.<br>• Electromagnetic interference (EMI) on the reference circuit can cause an engine misfire condition. A sudden increase in indicated RPM with little change in actual engine RPM change indicates EMI is present. Inspect for high voltage components near ignition control circuits if a condition exists.<br>• Inspect the intake manifold and the exhaust manifold passages for casting flash. |

**POOR FUEL ECONOMY**

**Poor Fuel Economy**

| Inspections | Action |
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| DEFINITION: Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, fuel economy is noticeably lower than the economy was on this vehicle at one time, as previously shown by an actual road test. | |
| Preliminary | • Refer to Important Preliminary Inspections Before Starting in **Symptoms - Engine Controls** . |

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| | • Search for bulletins.<br>• Verify that the powertrain control module (PCM) grounds are clean, tight, and in the proper locations. Refer to **Power and Grounding Component Views** in Wiring Systems and **Engine Controls Schematics** .<br>• Inspect the owners driving habits.<br>  ○ Is the A/C ON or the Defroster mode ON full time?<br>  ○ Are the tires at the correct pressure?<br>  ○ Are the wheels and tires the correct size?<br>  ○ Are there excessively heavy loads being carried?<br>  ○ Is the acceleration rate too much, too often?<br>• Remove the air filter element and inspect for dirt or for restrictions. Refer to **Air Cleaner Element Replacement** . Replace as necessary. |
| Fuel System | • Inspect the type, quality, and alcohol content of the fuel. Oxygenated fuels have lower energy and may deliver reduced fuel economy. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>• Inspect the fuel injectors. Refer to **Fuel Injector Coil Test** , **Fuel Injector Balance Test with Special Tool** or **Fuel Injector Balance Test with Tech 2** .<br>• Inspect for incorrect fuel pressure. Refer to **Fuel System Diagnosis** .<br>• Inspect for a contaminated fuel condition. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>• Inspect that each fuel injector harness is connected to the correct injector and cylinder. Relocate the injector harnesses as necessary.<br>• Inspect for foreign material accumulation in the throttle bore, coking on the throttle valve, or on the throttle shaft.<br>• Inspect for the following that may cause the engine to run rich:<br>**NOTE:**<br>**Refer to Heated Oxygen and Oxygen Sensor Notice in Cautions and Notices.**<br>  ○ Water intrusion in the heated oxygen sensor (HO2S) connector<br>  ○ Engine oil contaminated by fuel<br>  ○ An evaporative emissions (EVAP) canister purge condition<br>  ○ Incorrect fuel pressure-Refer to **Fuel System Diagnosis** .<br>  ○ Leaking fuel injectors-Refer to **Fuel System Diagnosis** .<br>  ○ An inaccurate mass air flow (MAF) sensor<br>  ○ Blockage on the inlet screen of the MAF sensor-Refer to **Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor Replacement** . |

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| | ○ Vacuum hoses that are split, kinked, or improperly connected<br>○ An air intake duct that is collapsed or restricted-Refer to **Air Cleaner Resonator Outlet Duct Replacement** .<br>○ An air filter that is dirty or restricted-Refer to **Air Cleaner Element Replacement** . |
| Sensor/System | • Inspect the air intake system and crankcase for air leaks.<br>• Inspect the crankcase ventilation valve for proper operation. Refer to **Crankcase Ventilation System Inspection/Diagnosis** in Engine Mechanical.<br>• Inspect for an inaccurate speedometer. Refer to **Symptoms - Instrument Panel, Gauges and Console** in Instrument Panel, Gauges, and Console.<br>• Use a scan tool in order to monitor the knock sensor (KS) system for excessive spark retard activity. Refer to **Knock Sensor (KS) System Description** . |
| Ignition System | • Inspect for proper ignition voltage output with the **J 26792** Spark Tester.<br>• Remove the spark plugs and inspect for the following:<br>○ Wet plugs<br>○ Cracks<br>○ Wear<br>○ Improper gap<br>○ Burned electrodes<br>○ Heavy deposits<br><br>Refer to **Spark Plug Inspection** .<br><br>• An improper spark plug gap will cause a driveability problem. Refer to **Spark Plug Inspection** . Gap the spark plugs using a wire gauge gap tool. Refer to **Spark Plug Replacement** .<br>• Determine the cause of the fouling before replacing the spark plugs. Refer to **Spark Plug Inspection** .<br>• Visually and physically inspect the secondary ignition for the following:<br>○ Ignition wires arcing to ground<br>○ Ignition wires for proper routing<br>• Soaking the secondary ignition system with water from a spray bottle may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply water.<br>• Inspect for loose ignition coil grounds. Refer to **Electronic Ignition (EI) System Diagnosis** . |
| Engine Cooling System | • Inspect the engine coolant level for being low. Refer to **Loss of Coolant** in Engine Cooling.<br>• Inspect the engine thermostat for proper operation and for the correct heat range. Refer to **Thermostat Diagnosis** in Engine Cooling. |
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| Engine Mechanical | • Inspect engine mechanical for the following:<br>  ○ Compression-Refer to **Engine Compression Test** in Engine Mechanical.<br>  ○ Sticking or leaking valves<br>  ○ Worn camshaft lobes<br>  ○ Valve timing<br>  ○ Bent push rods<br>  ○ Worn rocker arms<br>  ○ Broken valve springs<br>  ○ Excessive oil in combustion chamber-Leaking valve seals. Refer to **Oil Consumption Diagnosis** in Engine Mechanical.<br>• For incorrect basic engine parts inspect for the following:<br>  ○ The camshaft - Refer to **Camshaft and Bearings Cleaning and Inspection** in Engine Mechanical.<br>  ○ The cylinder heads - Refer to **Cylinder Head Cleaning and Inspection** in Engine Mechanical.<br>  ○ The pistons, etc. - Refer to **Piston, Connecting Rod, and Bearings Cleaning and Inspection** in Engine Mechanical.<br><br>Refer to **Symptoms - Engine Mechanical** in Engine Mechanical for diagnostic procedures. |
| Additional Inspections | • Visually and physically check the vacuum hoses for splits, kinks, and proper connections and routing as shown on Vehicle Emission Control Information label.<br>• Inspect the transmission torque converter clutch (TCC) operation. The scan tool should indicate a RPM drop, when the system commands the TCC ON. Refer to **Diagnostic System Check - Automatic Transmission** in Automatic Transmission - 4L60-E.<br>• Inspect the exhaust system for a possible restriction. Inspect for the following:<br>  ○ Inspect the exhaust system for damaged or collapsed pipes.<br>  ○ Inspect the mufflers for heat distress or possible internal failure.<br>  ○ Inspect for possible plugged catalytic converters. Refer to **Restricted Exhaust** in Engine Exhaust.<br><br>• Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A scan tool can usually detect EMI by monitoring the engine RPM. A sudden increase in RPM with little change in actual engine RPM change indicates EMI is present. Inspect for high voltage components, near ignition control circuits, if a condition exists.<br>• Inspect the park neutral position (PNP) switch circuit. Refer to **Park/Neutral Position Switch Adjustment** in Automatic Transmission - 4L60-E.<br>• Inspect the intake and the exhaust manifold passages for casting flash. |

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| | • Inspect the brake system for dragging or improper operation. Refer to **Brakes Drag** in Hydraulic Brakes. Verify that the vehicle operator does not drive with a foot on the brake pedal. |

**POOR FUEL FILL QUALITY**

**Poor Fuel Fill Quality**

| Problem | Causes |
|---|---|
| DEFINITION: Difficulty when refueling the vehicle. | |
| Difficult to fill | • The check valve is stuck closed.<br>• The fill limiter vent valve is stuck closed.<br>• The evaporative emission (EVAP) canister is restricted.<br>• The EVAP canister vent solenoid is stuck closed.<br>• Restricted EVAP pipes<br>• High Reid vapor pressure<br>• High fuel temperature<br>• The fuel filler hose/pipe is pinched, kinked or blocked.<br>• The fuel feed hose, or crossover hose, is pinched, kinked or blocked.<br>• The ignition switch is ON. |
| Over fill | • The pressure relief valve in the fill limiter vent valve is stuck open.<br>• The pressure relief valve in the fill limiter vent is valve leaking.<br>• The fill limiter vent valve is stuck open.<br>• The fill limiter vent valve is leaking. |
| Premature shut-off of the fuel dispensing nozzle | • The check valve is stuck closed.<br>• The fill limiter vent valve is stuck closed.<br>• The EVAP canister is restricted.<br>• The EVAP canister vent solenoid is stuck closed.<br>• Restricted EVAP pipes<br>• High Reid vapor pressure<br>• High fuel temperature<br>• The fuel filler hose/pipe is pinched, kinked or blocked.<br>• The fuel feed hose, or crossover hose, is pinched, kinked or blocked.<br>• The ignition switch is ON. |
| Fuel spit back | • The check valve is stuck open. |

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| | • The check valve is stuck closed.<br>• The check valve is leaking.<br>• High Reid vapor pressure<br>• High fuel temperature |
| Liquid fuel in the EVAP canister | • The fill limiter vent valve is stuck open.<br>• The fill limiter vent valve is leaking. |
| Liquid fuel leak | • The pressure relief valve in the fill limiter vent valve is stuck open.<br>• The pressure relief valve in the fill limiter vent valve is leaking.<br>• The fuel filler hose is loose or torn.<br>• The fuel feed hose, or crossover hose, is loose or torn.<br>• The fill limiter vent valve is stuck open. |
| Fuel odor | • The pressure relief valve in the fill limiter vent valve is stuck open.<br>• The pressure relief valve in the fill limiter vent valve is leaking.<br>• The EVAP canister is saturated. |

**ROUGH, UNSTABLE, OR INCORRECT IDLE AND STALLING**

**Rough, Unstable, or Incorrect Idle and Stalling**

| Inspections | Action |
|---|---|
| DEFINITION: Engine runs unevenly at idle. If severe, the engine or vehicle may shake. Engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine. | |
| Preliminary Inspections | • Refer to Important Preliminary Inspections Before Starting in **Symptoms - Engine Controls** .<br>• Search for bulletins.<br>• Verify that the powertrain control module (PCM) grounds are clean, tight, and in the proper locations. Refer to **Power and Grounding Component Views** in Wiring Systems and **Engine Controls Schematics** .<br>• Remove and inspect the air filter element for dirt or for restrictions. Refer to **Air Cleaner Element Replacement** . Replace as necessary. |
| Fuel System | • Inspect the fuel injectors. Refer to **Fuel Injector Coil Test** , **Fuel Injector Balance Test with Special Tool** or **Fuel Injector Balance Test with Tech 2** .<br>• Inspect for incorrect fuel pressure. Refer to **Fuel System Diagnosis** .<br>• Inspect for a contaminated fuel condition. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>• Inspect that each fuel injector harness is connected to the correct |

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| | injector/cylinder. Relocate fuel injector harnesses as necessary.<br>• Inspect for the following that may cause the engine to run rich:<br>**NOTE:**<br>**Refer to Heated Oxygen and Oxygen Sensor Notice in Cautions and Notices.**<br>o Water intrusion in the heated oxygen sensor (HO2S) connector<br>o Engine oil contaminated by fuel<br>o An evaporative emissions (EVAP) canister purge condition<br>o Incorrect fuel pressure - Refer to **Fuel System Diagnosis** .<br>o Leaking fuel injectors - Refer to **Fuel System Diagnosis** .<br>o An inaccurate mass air flow (MAF) sensor<br>o Blockage on the inlet screen of the MAF sensor - Refer to **Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor Replacement** .<br>o Vacuum hoses that are split, kinked, or improperly connected<br>o An air intake duct that is collapsed or restricted-Refer to **Air Cleaner Resonator Outlet Duct Replacement** .<br>o An air filter that is dirty or restricted - Refer to **Air Cleaner Element Replacement** .<br>• Inspect for the following conditions that may cause the engine to run lean:<br>**NOTE:**<br>**Refer to Heated Oxygen and Oxygen Sensor Notice in Cautions and Notices.**<br>o Water intrusion in the HO2S connector<br>o An exhaust leak between the HO2S and the engine-Refer to **Exhaust Leakage** in Engine Exhaust.<br>o Vacuum leaks<br>o Incorrect fuel pressure - Refer to **Fuel System Diagnosis** .<br>o Restricted fuel injectors - Refer to **Fuel Injector Balance Test with Special Tool** or **Fuel Injector Balance Test with Tech 2** .<br>o An inaccurate MAF sensor<br>o Fuel contamination - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>o Vacuum hoses that are split, kinked, or improperly connected |
| Sensor/System | • Inspect the crankcase ventilation valve for proper operation. Refer to **Crankcase Ventilation System Inspection/Diagnosis** in Engine Mechanical.<br>• Use a scan tool in order to monitor the knock sensor (KS) system for excessive |

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| | spark retard activity. |
| Ignition System | • Inspect for proper ignition voltage output with the **J 26792** Spark Tester. Refer to **Electronic Ignition (EI) System Diagnosis** for procedure.<br>• Remove spark plugs and check for the following:<br>  ○ Wet plugs<br>  ○ Cracks<br>  ○ Wear<br>  ○ Improper gap<br>  ○ Burned electrodes<br>  ○ Heavy deposits<br><br>Refer to **Spark Plug Inspection** .<br><br>• An improper spark plug gap will cause a driveability problem. Refer to **Spark Plug Inspection** . Gap the spark plugs using a wire gauge gap tool. Refer to **Spark Plug Replacement** .<br>• Determine the cause of the fouling before replacing the spark plugs.<br>• Visually and physically inspect secondary ignition for the following:<br>  ○ Ignition wires arcing to ground<br>  ○ Ignition wires for proper routing<br>• Soak the secondary ignition system with water from a spray bottle. Soaking the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply water.<br>• Monitor the Misfire Current Counters while driving the vehicle in the conditions that the misfire occurred. If a misfiring cylinder can be located, use the DTC P0300 table for diagnosis. Refer to **DTC P0300** .<br>• Inspect for loose ignition coil grounds. Refer to **Electronic Ignition (EI) System Diagnosis** . |
| Engine Mechanical | • Inspect engine mechanical for the following:<br>  ○ Compression - Refer to **Engine Compression Test** in Engine Mechanical.<br>  ○ Sticking or leaking valves<br>  ○ Worn camshaft lobes<br>  ○ Valve timing<br>  ○ Bent push rods<br>  ○ Worn rocker arms<br>  ○ Broken valve springs<br>  ○ Excessive oil in combustion chamber or leaking valve seals - Refer to **Oil Consumption Diagnosis** in Engine Mechanical.<br>• For incorrect basic engine parts. Inspect the following:<br>  ○ The camshaft - Refer to **Camshaft and Bearings Cleaning and** |

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| | **Inspection** in Engine Mechanical.<br>○ The cylinder heads - Refer to **Cylinder Head Cleaning and Inspection** in Engine Mechanical.<br>○ The pistons, etc. - Refer to **Piston, Connecting Rod, and Bearings Cleaning and Inspection** in Engine Mechanical.<br>• Inspect for excessive crankshaft endplay that will cause the crankshaft position (CKP) sensor reluctor wheel to move out of alignment with the CKP sensor. Refer to **Crankshaft and Bearings Cleaning and Inspection** in Engine Mechanical. This could result in any of the following conditions:<br>○ A no start<br>○ A start and stall<br>○ Erratic performance<br><br>Refer to **Symptoms - Engine Mechanical** in Engine Mechanical for diagnosis procedures. |
| Additional Inspections | • Inspect the exhaust system for possible restrictions. Inspect for the following:<br>○ Inspect the exhaust system for damaged or collapsed pipes.<br>○ Inspect the mufflers for heat distress or possible internal failure.<br>○ Inspect for possible plugged catalytic converters. Refer to **Restricted Exhaust** in Engine Exhaust.<br>• Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A scan tool can usually detect EMI by monitoring the engine RPM. A sudden increase in RPM with little change in actual engine RPM change indicates that EMI is present. If a problem exists, inspect routing of secondary ignition wires or high voltage components near the ignition control circuits.<br>• Inspect the park neutral position (PNP) switch circuit. Refer to **Park/Neutral Position Switch Adjustment** in Automatic Transmission - 4L60-E/4L65-E.<br>• Inspect for faulty motor mounts. Refer to **Engine Mount Inspection** in Engine Mechanical.<br>• Inspect the intake manifold and the exhaust manifold passages for casting flash. |

**DIESELING, RUN-ON**

**Dieseling, Run-On**

| Inspections | Action |
|---|---|
| DEFINITION: Engine continues to run after key is turned OFF, but runs very rough. If the engine runs smooth, inspect the ignition switch and the ignition switch adjustment. | |
| Preliminary Inspections | • Refer to Important Preliminary Inspections Before Starting in **Symptoms - Engine Controls** .<br>• Search for bulletins.<br>• Verify that the powertrain control module (PCM) grounds are clean, tight, and in |

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| | the proper locations. Refer to **Power and Grounding Component Views** in Wiring Systems and **Engine Controls Schematics** . |
| Fuel System | Inspect the fuel injectors for a leaking condition. Refer to **Fuel System Diagnosis** for the proper procedure. |

**BACKFIRE**

**Backfire**

| Inspections | Actions |
|---|---|
| DEFINITION: Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise. | |
| Preliminary Inspections | • Refer to Important Preliminary Inspections Before Starting in **Symptoms - Engine Controls** .<br>• Search for bulletins.<br>• Verify that the powertrain control module (PCM) grounds are clean, tight, and in the proper locations. Refer to **Power and Grounding Component Views** in Wiring Systems and **Engine Controls Schematics** . |
| Fuel System | • Inspect for incorrect fuel pressure. Refer to **Fuel System Diagnosis** .<br>• Inspect for a contaminated fuel condition. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (without Special Tool and E85)** or **Alcohol/Contaminants-in-Fuel Diagnosis (with Special Tool)** .<br>• Inspect the fuel injectors. Refer to **Fuel Injector Coil Test** , **Fuel Injector Balance Test with Special Tool** or **Fuel Injector Balance Test with Tech 2** .<br>• Verify that each injector harness is connected to the correct injector or cylinder. Relocate injector harnesses as necessary. |
| Sensor/System | • Inspect the air intake system and crankcase for air leaks.<br>• Inspect the crankcase ventilation valve for proper operation. Refer to **Crankcase Ventilation System Inspection/Diagnosis** in Engine Mechanical.<br>• Inspect for an inaccurate speedometer. Refer to **Symptoms - Instrument Panel, Gauges and Console** in Instrument Panel, Gauges, and Console.<br>• Use a scan tool in order to monitor the knock sensor (KS) system for excessive spark retard activity. Refer to **Knock Sensor (KS) System Description** . |
| Ignition System | • Inspect for proper ignition voltage output with **J 26792** Spark Tester.<br>• Remove spark plugs and inspect for the following:<br>  ○ Wet plugs<br>  ○ Cracks<br>  ○ Wear<br>  ○ Improper gap<br>  ○ Burned electrodes<br>  ○ Heavy deposits |

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| | Refer to **Spark Plug Inspection** .<br><br>• An improper spark plug gap will cause a driveability problem. Refer to **Spark Plug Inspection** . Gap the spark plugs using a wire gauge gap tool. Refer to **Spark Plug Replacement** .<br>• Determine the cause of the fouling before replacing the spark plugs. Refer to **Spark Plug Inspection** for diagnosis.<br>• Visually and physically inspect secondary ignition for the following:<br>  ○ Ignition wires arcing to ground<br>  ○ Ignition coils arcing to ground<br>• Soak the secondary ignition system with water from a spray bottle. Soaking the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water.<br>• Monitor the Misfire Current Counters while driving the vehicle in the conditions that the misfire occurred. If a misfiring cylinder can be located, use the DTC P0300 table for diagnosis. Refer to **DTC P0300**<br>• Inspect for loose ignition coil grounds. Refer to **Electronic Ignition (EI) System Diagnosis** . |
| Engine Cooling System | • Inspect the engine coolant level for being low. Refer to **Loss of Coolant** in Engine Cooling.<br>• Inspect the engine thermostat for proper operation and for the correct heat range. Refer to **Thermostat Diagnosis** in Engine Cooling. |
| Engine Mechanical | • Inspect engine mechanical for the following:<br>  ○ Compression - Refer to **Engine Compression Test** in Engine Mechanical.<br>  ○ Sticking or leaking valves<br>  ○ Worn camshaft lobes<br>  ○ Valve timing<br>  ○ Bent push rods<br>  ○ Worn rocker arms<br>  ○ Broken valve springs<br>  ○ Excessive oil in combustion chamber or leaking valve seals - Refer to **Oil Consumption Diagnosis** in Engine Mechanical.<br>• For incorrect basic engine parts. Inspect the following:<br>  ○ The camshaft - Refer to **Camshaft and Bearings Cleaning and Inspection** in Engine Mechanical.<br>  ○ The cylinder heads - Refer to **Cylinder Head Cleaning and Inspection** in Engine Mechanical.<br>  ○ The pistons, etc. - Refer to **Piston, Connecting Rod, and Bearings Cleaning and Inspection** in Engine Mechanical.<br>• Refer to **Symptoms - Engine Mechanical** in Engine Mechanical for diagnosis |

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| | procedures. |
| Additional Inspections | • Visually and physically inspect the vacuum hoses for splits, kinks, and proper connections and routing as shown on the Vehicle Emission Control Information label.<br>• Inspect the intake manifold and the exhaust manifold passages for casting flash.<br>• Inspect the transmission torque converter clutch (TCC) operation. The scan tool should indicate an RPM drop when the TCC is commanded ON. Refer to **Diagnostic System Check - Automatic Transmission** in Automatic Transmission - 4L60-E.<br>• Inspect the exhaust system for possible restrictions. Inspect the following:<br>  ○ Inspect the exhaust system for damaged or collapsed pipes.<br>  ○ Inspect the mufflers for heat distress or possible internal failure.<br>  ○ Inspect for possible plugged catalytic converters. Refer to **Restricted Exhaust** in Engine Exhaust.<br>• Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A scan tool can usually detect EMI by monitoring the engine RPM. A sudden increase in RPM with little change in actual engine RPM change may indicate that EMI is present. If a problem exists, inspect for high voltage components near the ignition control circuits.<br>• Inspect the park/neutral position (PNP) switch operation. Refer to **Park/Neutral Position Switch Adjustment** in Automatic Transmission - 4L60-E.<br>• Inspect for faulty motor mounts. Refer to **Engine Mount Inspection** in Engine Mechanical.<br>• Inspect the intake manifold and the exhaust manifold passages for casting flash |

## MALFUNCTION INDICATOR LAMP (MIL) INOPERATIVE

#### Circuit Description

Voltage is supplied directly to the malfunction indicator lamp (MIL). The powertrain control module (PCM) turns the MIL ON by grounding the MIL control circuit. There should be a steady MIL with the ignition ON and the engine OFF.

#### MIL Operation

The MIL is located on the instrument panel cluster (IPC).

### MIL Function

- The MIL informs the driver that a malfunction has occurred and the vehicle should be taken in for service as soon as possible.
- The MIL illuminates during a bulb test and a system test.

- A DTC will be stored if a MIL is requested by the PCM.

**MIL Illumination**

- The MIL will illuminate with ignition switch ON and the engine not running.
- The MIL will turn OFF when the engine is started.
- The MIL will remain ON if the self-diagnostic system has detected a malfunction.
- The MIL may turn OFF if the malfunction is not present.
- If the MIL is illuminated and then the engine stalls, the MIL will remain illuminated so long as the ignition switch is ON.
- If the MIL is not illuminated and the engine stalls, the MIL will not illuminate until the ignition switch is cycled OFF, then ON.

**Test Description**

The number below refers to the step number on the diagnostic table.

**4:** This step tests for a short to voltage on the MIL control circuit. With the fuse removed there should be no voltage on the MIL control circuit.

**Malfunction Indicator Lamp (MIL) Inoperative**

| Step | Action | Values | Yes | No |
|---|---|---|---|---|
| **Schematic Reference: Engine Controls Schematics**<br>**Connector End View Reference: Engine Controls Component Views or Powertrain Control Module (PCM) Connector End Views** | | | | |
| 1 | Did you perform the Diagnostic System Check - Engine Controls? | - | Go to **Step 2** | Go to **Diagnostic System Check - Engine Controls** |
| 2 | 1. Verify whether the instrument cluster is operational. If the instrument panel (IP) is completely inoperative, refer to **Diagnostic System Check - Instrument Cluster** in Instrument Panel, Gauges and Console.<br>2. Command the MIL ON and OFF with a scan tool.<br><br>Does the MIL turn ON and OFF when commanded with a scan tool? | - | Go to **Intermittent Conditions** | Go to **Step 3** |
| 3 | Inspect the fuse that supplies voltage to the MIL. Is the fuse open? | - | Go to **Step 10** | Go to **Step 4** |
| | 1. Turn OFF the ignition.<br>2. Remove the fuse that supplies voltage to the MIL. | | | |

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|---|---|---|---|---|
| **4** | 3. Disconnect the powertrain control module (PCM).<br>4. Turn ON the ignition with the engine OFF.<br>5. Measure the voltage from the MIL control circuit in the PCM harness connector to a good ground.<br><br>Is the voltage less than the specified value? | 0.3 V | Go to **Step 5** | Go to **Step 11** |
| 5 | 1. Turn OFF the ignition.<br>2. Install the fuse that supplies voltage to the MIL.<br>3. Turn ON the ignition with the engine OFF.<br>4. Connect a 3-amp fused jumper wire between the MIL control circuit in the PCM harness connector and a good ground.<br><br>Is the MIL illuminated? | - | Go to **Step 9** | Go to **Step 6** |
| 6 | 1. Turn OFF the ignition.<br>2. Remove the instrument panel cluster (IPC). Refer to **Instrument Panel Cluster (IPC) Replacement** in Instrument Panel, Gauges, and Console.<br>3. Turn ON the ignition, with the engine OFF.<br>4. Probe the MIL voltage supply circuit of the IPC harness connector with a test lamp that is connected to a good ground.<br><br>Does the test lamp illuminate? | - | Go to **Step 7** | Go to **Step 12** |
| 7 | Test the MIL control circuit for an open or high resistance. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems.<br>Did you find and correct a condition? | - | Go to **Step 15** | Go to **Step 8** |
| 8 | Test for an intermittent and for a poor connection at the IPC. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** in Wiring Systems.<br>Did you find and correct the condition? | - | Go to **Step 15** | Go to **Step 13** |
| 9 | Test for an intermittent and for a poor connection at the PCM. Refer to Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** in Wiring Systems.<br>Did you find and correct the condition? | - | Go to **Step 15** | Go to **Step 14** |
| | Repair the short to ground in the voltage supply | | | |

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|---|---|---|---|---|
| 10 | circuit. Refer to **Wiring Repairs** in Wiring Systems.<br>Did you complete the repair? | - | Go to **Step 15** | - |
| 11 | Repair the short to voltage in the MIL control circuit. Refer to **Wiring Repairs** in Wiring Systems.<br>Did you complete the repair? | - | Go to **Step 15** | - |
| 12 | Repair the open in the MIL voltage supply circuit. Refer to **Wiring Repairs** in Wiring Systems.<br>Did you complete the repair? | - | Go to **Step 15** | - |
| 13 | Replace the IPC. Refer to **Instrument Panel Cluster (IPC) Replacement** in Instrument Panel, Gauges, and Console.<br>Did you complete the replacement? | - | Go to **Step 15** | - |
| 14 | Replace the PCM. Refer to **Powertrain Control Module (PCM) Replacement** .<br>Did you complete the replacement? | - | Go to **Step 15** | - |
| 15 | 1. Turn OFF the ignition for 30 seconds.<br>2. Start the engine.<br>3. Observe the MIL.<br><br>Does the MIL operate correctly? | - | Go to **Step 16** | Go to **Step 2** |
| 16 | Observe the Capture Info with a scan tool.<br>Are there any DTCs that have not been diagnosed? | - | Go to **Diagnostic Trouble Code (DTC) List** | System OK |

## MALFUNCTION INDICATOR LAMP (MIL) ALWAYS ON

#### Circuit Description

Voltage is supplied directly to the malfunction indicator lamp (MIL). The powertrain control module (PCM) turns the MIL ON by grounding the MIL control circuit.

#### MIL Operation

The MIL is located on the instrument panel (IPC).

### MIL Function

- The MIL informs the driver that a malfunction has occurred and the vehicle should be taken in for service as soon as possible.
- The MIL illuminates during a bulb test and a system test.
- A DTC will be stored if a MIL is requested by the diagnostic.

### MIL Illumination

- The MIL will illuminate with ignition switch ON and the engine not running.
- The MIL will turn OFF when the engine is started.
- The MIL will remain ON if the self-diagnostic system has detected a malfunction.
- The MIL may turn OFF if the malfunction is not present.
- If the MIL is illuminated and then the engine stalls, the MIL will remain illuminated so long as the ignition switch is ON.
- If the MIL is not illuminated and the engine stalls, the MIL will not illuminate until the ignition switch is cycled OFF, then ON.

**Diagnostic Aids**

If the problem is intermittent, refer to **Intermittent Conditions** .

**Test Description**

The number below refers to the step number on the diagnostic table.

**2:** This step determines if the condition is with the MIL control circuit or the PCM.

**Malfunction Indicator Lamp (MIL) Always On**

| Step | Action | Yes | No |
|---|---|---|---|
| **Schematic Reference: Engine Controls Schematics<br>Connector End View Reference: Engine Controls Component Views or Powertrain Control Module (PCM) Connector End Views** | | | |
| 1 | Did you perform the Diagnostic System Check - Engine Controls? | Go to **Step 2** | Go to **Diagnostic System Check - Engine Controls** |
| **2** | 1. Turn OFF the ignition.<br>2. Disconnect the PCM.<br>3. Turn ON the ignition, with the engine OFF.<br>4. Observe the MIL.<br><br>Is the MIL illuminated? | Go to **Step 3** | Go to **Step 5** |
| 3 | 1. Remove the instrument panel cluster (IPC). Refer to **Instrument Panel Cluster (IPC) Replacement** in Instrument Panel, Gauges, and Console.<br>2. Test the MIL control circuit for a short to ground. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems.<br><br>Did you find and correct the condition? | Go to **Step 6** | Go to **Step 4** |
| | Replace the IPC. Refer to **Instrument Panel Cluster** | | |

| | | | |
|---|---|---|---|
| 4 | **(IPC) Replacement** in Instrument Panel, Gauges, and Console.<br>Did you complete the replacement? | Go to **Step 6** | - |
| 5 | Replace the PCM. Refer to **Powertrain Control Module (PCM) Replacement** .<br>Did you complete the replacement? | Go to **Step 6** | - |
| 6 | 1. Turn the ignition OFF for 30 seconds.<br>2. Start the engine.<br>3. Observe the MIL.<br><br>Does the MIL operate correctly? | Go to **Step 7** | Go to **Step 2** |
| 7 | Observe the Capture Info with a scan tool.<br>Are there any DTCs that have not been diagnosed? | Go to **Diagnostic Trouble Code (DTC) List** | System OK |

## ENGINE CRANKS BUT DOES NOT RUN

### Description

The Engine Cranks but Does Not Run diagnostic table is an organized approach to identifying a condition that causes an engine to not start. The diagnostic table directs the service technician to the appropriate system diagnosis. The diagnostic table assumes the following conditions are met:

- The battery is completely charged. Refer to **Battery Inspection/Test (Non-HP2)** in Engine Electrical.
- The engine cranking speed is acceptable. Refer to **Engine Cranks Slowly** in Engine Electrical.
- There is adequate fuel in the fuel tank.

**Engine Cranks but Does Not Run**

| Step | Action | Values | Yes | No |
|---|---|---|---|---|
| **Schematic Reference: Engine Controls Schematics<br>Connector End View Reference: Engine Controls Connector End Views or Powertrain Control Module (PCM) Connector End Views** | | | | |
| 1 | Did you perform the Diagnostic System Check - Engine Controls? | - | Go to **Step 2** | Go to **Diagnostic System Check - Engine Controls** |
| 2 | Crank the engine for the specified amount of time.<br>Does the scan tool display any DTCs that failed this ignition? | 15 seconds | Go to **Diagnostic Trouble Code (DTC) List** | Go to **Step 3** |
| 3 | Does the scan tool display any body control module (BCM) vehicle theft deterrent (VTD) DTCs? | - | Go to **Diagnostic System Check -** | |

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| | | | **Theft Deterrent** in Theft Deterrent | Go to **Step 4** |
| 4 | 1. Turn ON the ignition, with the engine OFF.<br>2. Probe both sides of the powertrain control module (PCM) 1 fuse located in the underhood electrical center with a test lamp connected to a good ground.<br><br>Does the test lamp illuminate on at least one side of the fuse? | - | Go to **Step 5** | Go to **Ignition Relay Diagnosis** |
| 5 | Monitor the ignition 1 signal parameter with a scan tool.<br>Is the ignition 1 signal parameter at the specified value? | B+ | Go to **Step 6** | Go to **Step 10** |
| 6 | Command the fuel pump ON with a scan tool.<br>Does the fuel pump operate? | - | Go to **Step 7** | Go to **Fuel Pump Electrical Circuit Diagnosis** |
| 7 | 1. Turn OFF the ignition.<br>2. Disconnect a spark plug wire.<br>3. Install the **J 26792** Spark Tester.<br>4. Attempt to start the engine.<br>5. Repeat test for remaining cylinders.<br><br>Does the spark tester spark for all cylinders? | - | Go to **Step 8** | Go to **Electronic Ignition (EI) System Diagnosis** |
| 8 | 1. Turn OFF the ignition.<br>2. Install a fuel pressure gauge. Refer to **Fuel System Diagnosis** .<br><br>**IMPORTANT:**<br>**The fuel pump operates for about 2 seconds when the ignition is turned ON. The fuel pressure must be observed when the fuel pump is operating.**<br><br>3. Turn ON the ignition, with the engine OFF.<br>4. Observe the fuel pressure while the fuel pump is operating.<br><br>Is the fuel pressure within the specified range? | VIN V, T, U Gasoline: 385-425 kPa (55-62 psi) VIN Z Ethanol: 335-375 kPa (48-54 psi) | Go to **Step 9** | Go to **Fuel System Diagnosis** |
| | Inspect for the following conditions: | | | |

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|---|---|---|---|---|
| 9 | • The engine coolant temperature (ECT) sensor is not close to the actual engine temperature. Refer to **DTC P0125** .<br>• The duct work between the mass air flow (MAF) sensor and the throttle body for air leaks<br>• A restricted exhaust system-Refer to **Restricted Exhaust** in Engine Exhaust.<br>• A malfunctioning MAF sensor may cause a no start or a stall after a start. If you suspect this, disconnect the MAF sensor. The PCM will default to the speed density in order to calculate the engine load and the intake air flow. If disconnecting the MAF sensor corrects the condition and the connections are OK. Refer to **DTC P0102** .<br>• The spark plugs for being gas fouled-Refer to **Spark Plug Inspection** .<br>• An engine mechanical failure that causes an engine not to start such as timing chain, low compression-Refer to **Engine Compression Test** and **Symptoms - Engine Mechanical** in Engine Mechanical - 4.8L, 5.3L, and 6.0L.<br>• Compare the MAP/BARO parameters to another vehicle. The parameter values should be close to each other.<br><br>Did you complete the action? | - | Go to **Step 13** | - |
| 10 | 1. Test the ignition 1 voltage circuits that are supplied by the PCM 1 fuse for an open or for a short to ground. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems.<br>2. Replace the fuse if necessary.<br><br>Did you find and correct the condition? | - | Go to **Step 13** | Go to **Step 11** |
| 11 | Inspect for poor connections at the harness connector of the PCM. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** in Wiring Systems.<br>Did you find and correct the condition? | - | Go to **Step 13** | Go to **Step 12** |
| 12 | Replace the PCM. Refer to **Powertrain Control Module (PCM) Replacement** . | - | | |

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| | Did you complete the replacement? | | Go to **Step 13** | - |
| 13 | 1. Clear the DTCs with a scan tool.<br>2. Turn OFF the ignition for 30 seconds.<br>3. Attempt to start the engine.<br><br>Does the engine start the continue to run? | - | Go to **Step 14** | Go to **Step 2** |
| 14 | 1. Allow the engine to reach operating temperature.<br>2. Observe the DTC information with a scan tool.<br><br>Are there any DTCs that have not been diagnosed? | - | Go to **Diagnostic Trouble Code (DTC) List** | System OK |

## IGNITION RELAY DIAGNOSIS

### Circuit Description

The ignition relay is a normally open relay. The relay armature is held in the open position by spring tension. When the ignition switch is turned to the run or start position, current will flow through the relay coil. A wire connected to the other end of the relay coil completes the path to ground. The electromagnetic field created by the relay coil, overcomes the spring tension and moves the armature allowing the relay contacts to close. The closed relay contacts allow current to flow from the battery to the following fuses:

- PCM 1
- ETC/ECM
- INJ 1
- INJ 2
- SBA, if equipped.

When the ignition switch is turned to the OFF position, the electromagnetic field collapses. This action allows the spring tension to move the armature away from the relay contacts, which interrupts current flow to the fuses.

If the ignition relay fails to close, the engine will crank, but will not run. The class 2 communications will be available with the use of a scan tool.

The ignition relay table assumes that the vehicle battery is fully charged. Refer to **Battery Inspection/Test (Non-HP2)** in Engine Electrical.

### Ignition Relay Diagnosis

| Step | Action | Yes | No |
|---|---|---|---|
| **Schematic Reference: Power Distribution Schematics and Ground Distribution Schematics in Wiring Systems and Engine Controls Schematics**<br>**Connector End View Reference: Engine Controls Connector End Views or Powertrain Control** | | | |

**Module (PCM) Connector End Views**

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|---|---|---|---|
| 1 | Did you perform the Diagnostic System Check - Engine Controls? | Go to **Step 2** | Go to **Diagnostic System Check - Engine Controls** |
| 2 | 1. Turn ON the ignition, with the engine OFF.<br>2. Remove the underhood junction block cover.<br>3. Probe the following fuses with a test lamp that is connected to a good ground:<br>• PCM 1<br>• ETC/ECM<br>• INJ 1<br>• INJ 2<br>• SBA, if equipped.<br><br>Refer to **Probing Electrical Connectors** and **Troubleshooting with a Test Lamp** in Wiring Systems.<br><br>Does the test lamp illuminate on at least one test point of each fuse? | Go to **Step 3** | Go to **Step 10** |
| 3 | 1. Turn OFF the ignition.<br>2. Probe both test points of the PCM 1 fuse with a test lamp that is connected to a good ground. Refer to **Probing Electrical Connectors** and **Troubleshooting with a Test Lamp** in Wiring Systems.<br><br>Does the test lamp illuminate on either test point of the fuse? | Go to **Step 4** | Go to **Step 30** |
| 4 | 1. Turn OFF the ignition.<br>2. Remove the ignition relay from the underhood junction block with the **J 43244** Relay Puller Pliers. Refer to **Relay Replacement (Within an Electrical Center)** or **Relay Replacement (Attached to Wire Harness)** in Wiring Systems.<br><br>**NOTE:**<br>**Refer to Test Probe Notice in Cautions and Notices.**<br><br>3. Probe the ignition 1 voltage circuit of the ignition relay at the underhood junction block with a test lamp that is connected to a good ground. Refer to | | |

| | | | |
|---|---|---|---|
| | **Probing Electrical Connectors** and **Troubleshooting with a Test Lamp** in Wiring Systems.<br><br>Does the test lamp illuminate? | Go to **Step 7** | Go to **Step 5** |
| 5 | Test the relay load bus bar of the underhood junction block between the ignition relay and the fuses to the circuit components for a short to battery positive voltage. Refer to **Circuit Testing** in Wiring Systems.<br>Did you find a condition? | Go to **Step 29** | Go to **Step 6** |
| 6 | 1. Turn OFF the ignition.<br>2. Remove the following fuses from the underhood junction block:<br>• PCM 1<br>• ETC/ECM<br>• INJ 1<br>• INJ 2<br>• SBA, if equipped.<br>3. Probe the above fuse terminals in the underhood junction block with a test lamp that is connected to a good ground. Refer to **Probing Electrical Connectors** and **Troubleshooting with a Test Lamp** in Wiring Systems.<br><br>Does the test lamp illuminate at any of the fuse terminals? | Go to **Diagnostic System Check - Engine Electrical** in Engine Electrical | Go to **Step 27** |
| 7 | 1. Turn OFF the ignition.<br>2. Disconnect the negative battery cable at the battery. Refer to **Battery Negative Cable Disconnect/Connect Procedure (Single Battery)** in Engine Electrical.<br>3. Disconnect the underhood junction block electrical connector that contains the ignition 1 voltage circuit for the ignition relay.<br>4. Disconnect the ignition switch electrical connector that contains the ignition 1 voltage circuit for the ignition relay.<br>5. Connect the negative battery cable to the battery.<br>6. Test the ignition 1 voltage circuit for a short to battery positive voltage. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems.<br><br>Did you find and correct the condition? | Go to **Step 30** | Go to **Step 8** |
| | | | |

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|---|---|---|---|
| 8 | 1. Turn OFF the ignition.<br>2. Probe the ignition 1 voltage terminal on the ignition switch side of the ignition switch electrical connector with a test lamp that is connected to a good ground. Refer to **Probing Electrical Connectors** and **Troubleshooting with a Test Lamp** in Wiring Systems.<br><br>Does the test lamp illuminate? | Go to **Step 28** | Go to **Step 9** |
| 9 | Test the ignition 1 voltage bus bar circuit in the underhood junction block for a short to battery positive voltage. Refer to **Circuit Testing** in Wiring Systems.<br>Did you find a condition? | Go to **Step 29** | Go to **Step 27** |
| 10 | 1. Turn OFF the ignition.<br>2. Inspect the 40-amp IGN B fuse in the underhood junction block. Refer to **Circuit Protection - Fuses** in Wiring Systems.<br><br>Is the fuse open? | Go to **Step 11** | Go to **Step 18** |
| 11 | 1. Remove the 40-amp IGN B fuse from the underhood junction block.<br><br>**NOTE:**<br>**Refer to Test Probe Notice in Cautions and Notices.**<br><br>2. Probe both fuse terminals in the underhood junction block with a test lamp that is connected to a good ground. Refer to **Probing Electrical Connectors** and **Troubleshooting with a Test Lamp** in Wiring Systems.<br><br>Does the test lamp illuminate on at least one fuse terminal? | Go to **Step 12** | Go to **Step 17** |
| 12 | Test the ignition 1 voltage circuit between the ignition switch and the underhood junction block for a short to ground. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems.<br>Did you find and correct the condition? | Go to **Step 30** | Go to **Step 13** |
| 13 | Test the ignition switch assembly for a short to ground. Refer to **Circuit Testing** in Wiring Systems.<br>Did you find a condition? | Go to **Step 28** | Go to **Step 14** |
| 14 | Test the battery positive voltage circuit between the underhood junction block and the ignition switch for a short to ground. Refer to **Circuit Testing** and **Wiring** | | |

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|---|---|---|---|
| | **Repairs** in Wiring Systems.<br>Did you find and correct the condition? | Go to **Step 30** | Go to **Step 15** |
| 15 | Test the battery positive voltage bus bar circuit of the underhood junction block between the 40-amp IGN B fuse and the ignition switch for a short to ground.<br>Did you find a condition? | Go to **Step 29** | Go to **Step 16** |
| 16 | Test the ignition 1 voltage bus bar circuit of the underhood junction block that contains the ignition relay for a short to ground.<br>Did you find a condition? | Go to **Step 29** | Go to **Step 27** |
| 17 | 1. Turn OFF the ignition.<br>2. Probe the mounting stud for the battery positive cable at the underhood junction block with a test lamp that is connected to a good ground. Refer to **Probing Electrical Connectors** and **Troubleshooting with a Test Lamp** in Wiring Systems.<br><br>Does the test lamp illuminate? | Go to **Step 29** | Go to **Diagnostic System Check - Engine Electrical** in Engine Electrical |
| 18 | 1. Turn OFF the ignition.<br>2. Remove the ignition relay with the **J 43244** from the underhood junction block. Refer to **Relay Replacement (Within an Electrical Center)** or **Relay Replacement (Attached to Wire Harness)** in Wiring Systems.<br><br>**NOTE:**<br>**Refer to Test Probe Notice in Cautions and Notices.**<br><br>3. Probe the battery positive voltage circuit of the ignition relay at the underhood junction block with a test lamp that is connected to a good ground. Refer to **Probing Electrical Connectors** and **Troubleshooting with a Test Lamp** in Wiring Systems.<br><br>Does the test lamp illuminate? | Go to **Step 19** | Go to **Step 29** |
| 19 | 1. Turn ON the ignition, with the engine OFF.<br>2. Probe the ignition 1 voltage circuit of the ignition relay at the underhood junction block with a test lamp that is connected to a good ground. Refer to **Probing Electrical Connectors** and **Troubleshooting with a Test Lamp** in Wiring Systems. | | |

| | | | |
|---|---|---|---|
| | Does the test lamp illuminate? | Go to **Step 23** | Go to **Step 20** |
| 20 | 1. Turn OFF the ignition.<br>2. Test the ignition 1 voltage circuit between the ignition switch and the underhood junction block for a high resistance or for an open. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems.<br><br>Did you find and correct the condition? | Go to **Step 30** | Go to **Step 21** |
| 21 | Test the ignition switch assembly for a high resistance or for an open. Refer to **Circuit Testing** in Wiring Systems.<br>Did you find a condition? | Go to **Step 28** | Go to **Step 22** |
| 22 | Test the battery positive voltage circuit between the ignition switch and the underhood junction block for a high resistance or for an open. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems.<br>Did you find and correct the condition? | Go to **Step 30** | Go to **Step 29** |
| 23 | 1. Turn ON the ignition, with the engine OFF.<br>2. Probe the coil ground circuit of the ignition relay at the underhood junction block with a test lamp that is connected to battery voltage. Refer to **Probing Electrical Connectors** and **Troubleshooting with a Test Lamp** in Wiring Systems.<br><br>Does the test lamp illuminate? | Go to **Step 25** | Go to **Step 24** |
| 24 | 1. Turn OFF the ignition.<br>2. Disconnect the negative battery cable at the battery. Refer to **Battery Negative Cable Disconnect/Connect Procedure (Single Battery)** in Engine Electrical.<br>3. Disconnect the underhood junction block electrical connectors.<br>4. Test the coil ground circuit of the ignition relay at the underhood junction block electrical connector for a high resistance or for an open. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems.<br><br>Did you find and correct the condition? | Go to **Step 30** | Go to **Step 29** |
| | 1. Turn OFF the ignition.<br>2. Jumper the ignition relay battery positive voltage circuit and the ignition relay load circuit together at the underhood junction block with a 20-amp fused jumper wire. Refer to **Using Fused Jumper Wires** in Wiring Systems. | | |

| | | | |
|---|---|---|---|
| 25 | 3. Probe the following fuses with a test lamp that is connected to a good ground:<br>• PCM 1<br>• ETC/ECM<br>• INJ 1<br>• INJ 2<br>• SBA, if equipped.<br><br>Refer to **Probing Electrical Connectors** and **Troubleshooting with a Test Lamp** in Wiring Systems.<br><br>Does the test lamp illuminate on at least one test point of each fuse? | Go to **Step 26** | Go to **Step 29** |
| 26 | Test for an intermittent and for a poor connection at the underhood junction block, ignition relay connector location. Refer to **Testing for Intermittent Conditions and Poor Connections** in Wiring Systems.<br>Did you find a condition? | Go to **Step 29** | Go to **Step 27** |
| 27 | Replace the ignition relay. Refer to **Relay Replacement (Within an Electrical Center)** or **Relay Replacement (Attached to Wire Harness)** in Wiring Systems.<br>Did you complete the replacement? | Go to **Step 30** | - |
| 28 | Replace the ignition switch. Refer to **Ignition Switch Replacement** in Steering Wheel and Column.<br>Did you complete the replacement? | Go to **Step 30** | - |
| 29 | Replace the underhood electrical center. Refer to **Underhood Electrical Center or Junction Block Replacement** in Wiring Systems.<br>Did you complete the replacement? | Go to **Step 30** | - |
| 30 | 1. Replace any open fuses.<br>2. Turn OFF the ignition for 30 seconds.<br>3. Attempt to start the engine.<br><br>Does the engine start and run? | Go to **Step 31** | Go to **Engine Cranks but Does Not Run** |
| 31 | 1. Clear the DTCs with a scan tool.<br>2. Operate the vehicle for 5 minutes.<br><br>Does a DTC set during this ignition cycle? | Go to **Diagnostic Trouble Code (DTC) List** | System OK |

## FUEL PUMP ELECTRICAL CIRCUIT DIAGNOSIS

### Circuit Description

The control module enables the fuel pump relay when the ignition switch is turned ON. The control module will disable the fuel pump relay within two seconds unless the control module detects ignition reference pulses. The control module continues to enable the fuel pump relay as long as ignition reference pulses are detected. The control module disables the fuel pump relay within two seconds if ignition reference pulses cease to be detected and the ignition remains ON.

**Diagnostic Aids**

A fuel pump prime terminal is located at the underhood bussed electrical center (UBEC). Refer to the UBEC cover for terminal location.

The following conditions may have caused the fuel pump fuse to open:

- A faulty fuse
- An intermittent short in the fuel pump power supply circuit
- An intermittent internal component failure

For an intermittent condition, refer to **Intermittent Conditions** .

**Test Description**

The numbers below refer to the step numbers on the diagnostic table.

**3:** This step determines if the condition is located on the coil side or on the switch side of the fuel pump relay.

**4:** This step verifies that the powertrain control module (PCM) is providing voltage to the fuel pump relay.

**5:** This step tests for an open in the ground circuit to the fuel pump relay.

**6:** This step determines if a voltage is constantly being applied to the fuel pump relay.

**13:** This step determines if the condition with the circuit is intermittent.

**Fuel Pump Electrical Circuit Diagnosis**

| Step | Action | Yes | No |
|---|---|---|---|
| **Schematic Reference: Engine Controls Schematics**<br>**Connector End View Reference: Engine Controls Connector End Views or Powertrain Control Module (PCM) Connector End Views** | | | |
| 1 | Did you perform the Diagnostic System Check - Engine Controls? | Go to **Step 2** | Go to **Diagnostic System Check - Engine Controls** |
| 2 | 1. Turn ON the ignition, with the engine OFF.<br>2. Command the fuel pump relay ON and OFF with a scan tool.<br><br>Does the fuel pump turn ON and OFF when commanded with a | Go to Diagnostic | |

| | | | |
|---|---|---|---|
| | scan tool? | Aids | Go to **Step 3** |
| **3** | Command the fuel pump relay ON and OFF with a scan tool.<br>Does the fuel pump relay turn ON and OFF when commanded with a scan tool? | Go to **Step 9** | Go to **Step 4** |
| **4** | 1. Turn OFF the ignition.<br>2. Remove the fuel pump relay.<br>3. Turn ON the ignition, with the engine OFF.<br>4. Probe the control circuit of the fuel pump relay with a test lamp that is connected to a good ground. Refer to **Probing Electrical Connectors** in Wiring Systems.<br>5. Command the fuel pump relay ON and OFF with a scan tool.<br><br>Does the test lamp turn ON and OFF when commanded with a scan tool? | Go to **Step 5** | Go to **Step 6** |
| **5** | 1. Connect a test lamp between the control circuit of the fuel pump relay and the ground circuit of the fuel pump relay.<br>2. Command the fuel pump relay ON and OFF with a scan tool.<br><br>Does the test lamp turn ON and OFF when commanded with a scan tool? | Go to **Step 19** | Go to **Step 22** |
| **6** | Does the test lamp remain illuminated? | Go to **Step 7** | Go to **Step 8** |
| 7 | Test the control circuit of the fuel pump relay for a short to voltage. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems.<br>Did you find and correct the condition? | Go to **Step 28** | Go to **Step 27** |
| 8 | Test the control circuit of the fuel pump relay for a short to ground or for an open. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems.<br>Did you find and correct the condition? | Go to **Step 28** | Go to **Step 20** |
| 9 | Turn ON the ignition, with the engine OFF.<br>Does the fuel pump operate continuously? | Go to **Step 10** | Go to **Step 11** |
| 10 | 1. Turn OFF the ignition.<br>2. Remove the fuel pump relay.<br>3. Turn ON the ignition, with the engine OFF.<br><br>Does the fuel pump operate continuously? | Go to **Step 21** | Go to **Step 26** |
| 11 | Inspect the fuel pump fuse.<br>Is the fuel pump fuse open? | Go to **Step 12** | Go to **Step 14** |
| | 1. Test the supply voltage circuit of the fuel pump, between | | |

| | | | |
|---|---|---|---|
| 12 | the fuel pump fuse and the fuel pump for a short to ground. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems.<br>2. Replace the fuel pump fuse if necessary.<br><br>Did you find and correct the condition? | Go to **Step 28** | Go to **Step 13** |
| **13** | 1. Install all removed electrical components.<br>2. Install a new fuel pump fuse.<br>3. Command the fuel pump relay ON with a scan tool.<br>4. Inspect the fuel pump fuse.<br><br>Is the fuel pump fuse open? | Go to **Step 24** | Go to **Intermittent Conditions** |
| 14 | 1. Turn OFF the ignition.<br>2. Remove the fuel pump relay.<br>3. Turn ON the ignition, with the engine OFF.<br>4. Probe the battery voltage circuit of the fuel pump relay switch with a test lamp that is connected to a good ground.<br><br>Does the test lamp illuminate? | Go to **Step 15** | Go to **Step 23** |
| 15 | Connect a 20-amp fused jumper wire between the battery voltage circuit of the fuel pump relay switch and the supply voltage circuit of the fuel pump.<br>Does the fuel pump operate? | Go to **Step 19** | Go to **Step 16** |
| 16 | Test the supply voltage circuit of the fuel pump, between the fuel pump relay and the fuel pump for an open or for high resistance. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems.<br>Did you find and correct the condition? | Go to **Step 28** | Go to **Step 17** |
| 17 | **IMPORTANT:**<br>**Inspect the ground circuit for being tight, corrosion on terminals, or damage to the wiring harness.**<br><br>Test the ground circuit of the fuel pump for an open or for high resistance. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems.Did you find and correct the condition? | Go to **Step 28** | Go to **Step 18** |
| 18 | Test for an intermittent or for a poor connection at the fuel pump sender assembly connector. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** in Wiring Systems.<br>Did you find and correct the condition? | Go to **Step 28** | Go to **Step 24** |
| 19 | Test for an intermittent or for a poor connection at the fuel pump relay. Refer to **Testing for Intermittent Conditions and** | | |

| | | | |
|---|---|---|---|
| | **Poor Connections** and **Connector Repairs** in Wiring Systems.<br>Did you find and correct the condition? | Go to **Step 28** | Go to **Step 26** |
| 20 | Test for an intermittent and for a poor connection at the harness connector of the powertrain control module (PCM). Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** in Wiring Systems.<br>Did you find and correct the condition? | Go to **Step 28** | Go to **Step 27** |
| 21 | Repair the short to voltage in the supply voltage circuit of the fuel pump. Refer to **Wiring Repairs** in Wiring Systems.<br>Did you complete the repair? | Go to **Step 28** | - |
| 22 | Repair the open in the fuel pump relay ground circuit. Refer to **Wiring Repairs** in Wiring Systems.<br>Did you complete the repair? | Go to **Step 28** | - |
| 23 | Repair the open in the battery voltage circuit of the fuel pump relay. Refer to **Wiring Repairs** in Wiring Systems.<br>Did you complete the repair? | Go to **Step 28** | - |
| 24 | Test for an intermittent and for a poor connection at the fuel pump sender assembly connector within the fuel tank. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** in Wiring Systems.<br>Did you find and correct the conditions? | Go to **Step 28** | Go to **Step 25** |
| 25 | 1. Replace the fuel pump sender assembly. Refer to **Fuel Sender Assembly Replacement** .<br>2. Replace the fuel pump fuse if necessary.<br><br>Did you complete the replacement? | Go to **Step 28** | - |
| 26 | Replace the fuel pump relay.<br>Did you complete the replacement? | Go to **Step 28** | - |
| 27 | Replace the PCM. Refer to **Powertrain Control Module (PCM) Replacement** .<br>Did you complete the replacement? | Go to **Step 28** | - |
| 28 | Operate the system in order to verify the repair.<br>Did you correct the condition? | System OK | Go to **Step 2** |

## FUEL SYSTEM DIAGNOSIS

#### System Description

The control module enables the fuel pump relay when the ignition switch is turned ON. The control module will disable the fuel pump relay within two seconds unless the control module detects ignition reference pulses. The control module continues to enable the fuel pump relay as long as ignition reference pulses are detected. The control module disables the fuel pump relay within two seconds if ignition reference pulses cease to be detected and the ignition remains ON.

The Fuel System is a returnless on-demand design. The fuel pressure regulator is a part of the fuel sender

assembly, eliminating the need for a return pipe from the engine. A returnless fuel system reduces the internal temperature of the fuel tank by not returning hot fuel from the engine to the fuel tank. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

The fuel tank stores the fuel supply. An electric turbine style fuel pump attaches to the fuel sender assembly inside the fuel tank. The fuel pump supplies high pressure fuel through the fuel filter and the fuel feed pipe to the fuel injection system. The fuel pump provides fuel at a higher rate of flow than is needed by the fuel injection system. The fuel pump also supplies fuel to a venturi pump located on the bottom of the fuel sender assembly. The function of the venturi pump is to fill the fuel sender assembly reservoir. The fuel pressure regulator, a part of the fuel sender assembly, maintains the correct fuel pressure to the fuel injection system. The fuel pump and sender assembly contains a reverse flow check valve. The check valve and the fuel pressure regulator maintain fuel pressure in the fuel feed pipe and the fuel rail in order to prevent long cranking times.

**Fuel System Diagnosis**

| Step | Action | Values | Yes | No |
|---|---|---|---|---|
| **Schematic Reference: Fuel Hose/Pipes Routing Diagram (Single Fuel Tank)** | | | | |
| 1 | Did you perform the Diagnostic System Check - Engine Controls? | - | Go to **Step 2** | Go to **Diagnostic System Check - Engine Controls** |
| 2 | **IMPORTANT:**<br>**Inspect the fuel system for external leaks before proceeding with this diagnostic.**<br>1. Turn ON the ignition, with the engine OFF.<br>2. Command the fuel pump relay ON with a scan tool.<br>Does the fuel pump operate? | - | Go to **Step 3** | Go to **Fuel Pump Electrical Circuit Diagnosis** |
| 3 | **IMPORTANT:**<br>**Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic.**<br>1. Turn OFF the ignition.<br>2. Turn OFF all accessories.<br>**CAUTION:**<br>**Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.**<br>3. Install a fuel pressure gauge. Refer to **Fuel Pressure** | 385-425 kPa (55-62 psi) VIN Z : | | |

| | | | | |
|---|---|---|---|---|
| | **Gauge Installation and Removal** .<br>4. Turn ON the ignition, with the engine OFF.<br>**IMPORTANT:**<br>• **The fuel pump relay may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.**<br>• **DO NOT start the engine.**<br>5. Command the fuel pump relay ON with a scan tool.<br>6. Observe the fuel pressure gauge with the fuel pump commanded ON.<br>Is the fuel pressure within the specified range? | 335-375 kPa (48-54 psi) | Go to **Step 4** | Go to **Step 8** |
| 4 | **IMPORTANT:**<br>**The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.**<br>Monitor the fuel pressure gauge for 1 minute.Does the fuel pressure decrease by more than the specified value? | 34 kPa (5 psi) | Go to **Step 7** | Go to **Step 5** |
| 5 | 1. Relieve the fuel pressure to the first specified value.<br>2. Monitor the fuel pressure gauge for 5 minutes.<br>Does the fuel pressure decrease by more than the second specified value? | 69 kPa (10 psi)<br>14 kPa (2 psi) | Go to **Step 12** | Go to **Step 6** |
| 6 | 1. Operate the vehicle within the conditions to reproduce the original symptoms.<br>2. Monitor the O2 and the Fuel Trim parameters with a scan tool.<br>Does the scan tool parameters indicate a lean condition? | - | Go to **Step 9** | Go to **Symptoms - Engine Controls** |
| 7 | 1. Turn OFF the ignition.<br>2. Relieve the fuel pressure. Refer to **Fuel Pressure Relief Procedure** .<br>3. Disconnect the chassis fuel hose from the engine compartment fuel pipe. Refer to **Quick Connect Fitting (s) Service (Metal Collar)** .<br>4. Install the **J 37287** Fuel Line Shut-off Adapter between the chassis fuel hose and the engine compartment fuel pipe.<br>5. Open the valve on the fuel pipe shut-off adapter. | - | | |

| | | | | |
|---|---|---|---|---|
| | 6. Turn ON the ignition, with the engine OFF.<br>7. Command the fuel pump relay ON with a scan tool.<br>8. Bleed the air from the fuel pressure gauge.<br>9. Command the fuel pump relay ON and then OFF with a scan tool.<br>10. Close the fuel feed pipe shut-off valve.<br>11. Monitor the fuel pressure gauge for 1 minute.<br><br>Does the fuel pressure remain constant? | | Go to **Step 12** | Go to **Step 11** |
| 8 | Is the fuel pressure more than the specified value? | 427 kPa (62 psi)<br>VIN Z: 375 kPa (54 psi) | Go to **Step 12** | Go to **Step 9** |
| 9 | Inspect the fuel feed pipe for a restriction.<br>Did you find and correct the condition? | - | Go to **Step 13** | Go to **Step 10** |
| 10 | Inspect the harness connectors and the ground circuits of the fuel pump for poor connections. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** in Wiring Systems.<br>Did you find and correct the condition? | - | Go to **Step 13** | Go to **Step 12** |
| 11 | 1. Turn OFF the ignition.<br>2. Raise the fuel rail, with the fuel lines connected. Refer to **Fuel Rail Assembly Replacement** .<br>3. Turn ON the ignition, with the engine OFF.<br>4. Command the fuel pump relay ON with a scan tool.<br>5. Replace any leaking fuel injectors. Refer to **Fuel Injector Replacement** .<br><br>Did you complete the replacement? | - | Go to **Step 13** | - |
| 12 | Replace the fuel sender. Refer to **Fuel Sender Assembly Replacement** .<br>Did you complete the replacement? | - | Go to **Step 13** | - |
| 13 | Operate the system in order to verify the repair.<br>Did you correct the condition? | - | System OK | Go to **Step 3** |

## FUEL INJECTOR COIL TEST

### Circuit Description

The control module enables the appropriate fuel injector pulse for each cylinder. Ignition voltage is supplied directly to the fuel injectors. The control module controls each fuel injector by grounding the control circuit via a solid state device called a driver. A fuel injector coil winding resistance that is too high or too low will affect

engine driveability. A fuel injector control circuit DTC may not set, but a misfire may be apparent. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

**Diagnostic Aids**

- The use of Dielectric compound GM P/N 12377900 (Canadian P/N 10953529) in the fuel injector electrical connector may eliminate a corrosion condition.
- Monitoring the misfire current counters, or misfire graph, may help isolate the fuel injector that is causing the condition.
- Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition.
- Perform the fuel injector coil test within the conditions of the customers concern. A fuel injector condition may only be apparent at a certain temperature, or under certain conditions.
- If the fuel injector coil test does not isolate the condition perform the fuel injector balance test. Refer to **Fuel Injector Balance Test with Special Tool** or **Fuel Injector Balance Test with Tech 2** .

**Fuel Injector Coil Test**

| Step | Action | Values | Yes | No |
|---|---|---|---|---|
| **Schematic Reference: Engine Controls Schematics**<br>**Connector End View Reference: Engine Controls Connector End Views or Powertrain Control Module (PCM) Connector End Views** | | | | |
| 1 | Did you perform the Diagnostic System Check - Engine Controls? | - | Go to **Step 2** | Go to **Diagnostic System Check - Engine Controls** |
| 2 | Observe the ECT sensor parameter with a scan tool.<br>Is the ECT sensor parameter within the specified range? | 10-32°C (50-90° F) | Go to **Step 3** | Go to **Step 4** |
| 3 | Measure the resistance of each fuel injector with a DMM. Refer to **Testing for Continuity** in Wiring Systems.<br>Do any of the fuel injectors display a resistance outside the specified range? | 11-14 ohm | Go to **Step 6** | Go to Diagnostic Aids |
| 4 | 1. Measure the resistance of each fuel injector with a DMM. Refer to **Testing for Continuity** in Wiring Systems.<br>2. Record each fuel injector value.<br>3. Subtract the lowest resistance value from the highest resistance value.<br><br>Is the difference equal to, or less than, the specified value? | 3 ohm | Go to **Fuel Injector Balance Test with Special Tool** or **Fuel Injector Balance Test with Tech 2** | Go to **Step 5** |

| | | | | |
|---|---|---|---|---|
| 5 | 1. Add all of the fuel injector resistance values, to obtain a total resistance value.<br>2. Divide the total resistance value by the number of fuel injectors, to obtain an average resistance value.<br>3. Subtract the lowest individual fuel injector resistance value from the average resistance value.<br>4. Compute the difference between the highest individual fuel injector resistance value and the average resistance value.<br>5. Replace the fuel injector that displays the greatest resistance difference, above or below the average. Refer to **Fuel Injector Replacement** .<br><br>Did you complete the replacement? | - | Go to **Step 7** | - |
| 6 | Replace the fuel injector or fuel injectors that are out of the specified range. Refer to **Fuel Injector Replacement** .<br>Did you complete the replacement? | 11-14 ohm | Go to **Step 7** | - |
| 7 | Operate the system in order to verify the repair.<br>Did you correct the condition? | - | System OK | Go to **Step 2** |

## FUEL INJECTOR BALANCE TEST WITH SPECIAL TOOL

### Description

The scan tool is first used to energize the fuel pump. The fuel injector tester is then used to pulse each injector for a precise amount of time, allowing a measured amount of fuel into the manifold. This causes a drop in system fuel pressure that can be recorded and used to compare each injector.

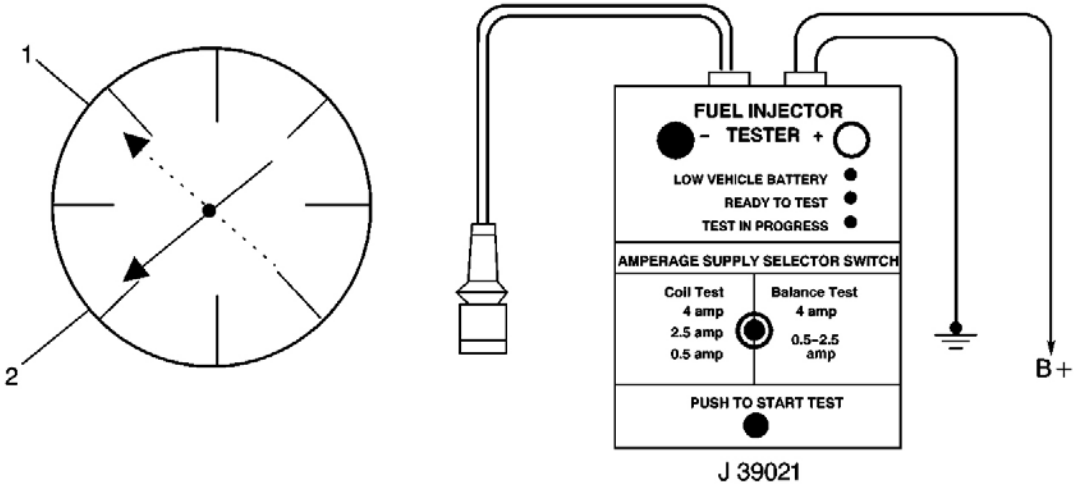


**Fig. 1: Fuel Injector Balance Test & Special Tool**
**Courtesy of GENERAL MOTORS CORP.**

**Callouts For Fig. 27**

| Callout | Component Name |
|---|---|
| 1 | First Fuel Pressure Gauge Reading |
| 2 | Second Fuel Pressure Gauge Reading |

**Fuel Injector Balance Test Example (Typical)**

| Cylinder | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1st Reading | 296 kPa (43 psi) | 296 kPa (43 psi) | 296 kPa (43 psi) | 296 kPa (43 psi) |
| 2nd Reading | 131 kPa (19 psi) | 117 kPa (17 psi) | 124 kPa (18 psi) | 145 kPa (21 psi) |
| Amount of Drop | 165 kPa (24 psi) | 179 kPa (26 psi) | 172 kPa (25 psi) | 151 kPa (22 psi) |
| Average Range: 156-176 kPa (22.5-25.5 psi) | Injector OK | Replace fuel injector - too much fuel pressure drop | Injector OK | Replace fuel injector - too little fuel pressure drop |

**Test Description**

The numbers below refer to the step numbers on the diagnostic table.

**6:** If the pressure drop value for each fuel injector is within 10 kPa (1.5 psi) of the average pressure drop value, the fuel injectors are flowing properly. Calculate the pressure drop value for each fuel injector by subtracting the second pressure reading from the first pressure reading. Refer to the illustration above.

**Fuel Injector Balance Test with Special Tool**

| | | | | |
|---|---|---|---|---|

| Step | Action | Values | Yes | No |
|---|---|---|---|---|
| **Schematic Reference: Engine Controls Schematics<br>Connector End View Reference: Engine Controls Connector End Views or Powertrain Control Module (PCM) Connector End Views** | | | | |
| 1 | Did you perform the Diagnostic System Check - Engine Controls? | - | Go to **Step 2** | Go to **Diagnostic System Check - Engine Controls** |
| 2 | Did you perform the Fuel Injector Coil Test? | - | Go to **Step 3** | Go to **Fuel Injector Coil Test** |
| 3 | **IMPORTANT:**<br>**Do not perform this test if the engine coolant temperature (ECT) is above 94°C (201°F).**<br><br>Observe the ECT Sensor parameter with a scan tool.Is the ECT Sensor parameter less than the specified value? | 94°C (201°F) | Go to **Step 4** | - |
| 4 | **IMPORTANT:**<br>**Verify there is adequate fuel in the fuel tank before proceeding with this diagnostic.**<br><br>1. Turn OFF the ignition.<br>2. Install the fuel pressure gauge. Refer to **Fuel Pressure Gauge Installation and Removal** .<br>3. Turn ON the ignition, with the engine OFF.<br>4. Command the fuel pump ON with a scan tool.<br><br>**IMPORTANT:**<br>• **You may need to command the fuel pump ON a few times, in order to obtain the highest possible fuel pressure.**<br>• **Do not start the engine.**<br><br>5. Observe the fuel pressure gauge, with the fuel pump commanded ON.<br><br>Is the fuel pressure within the specified range? | 385-425 kPa (55-62 psi) VIN: (V, T, U) Gasoline<br>335-375 kPa (48-54 psi) VIN Z Ethanol | Go to **Step 5** | Go to **Fuel System Diagnosis** |
| | **IMPORTANT:**<br>**The fuel pressure may vary slightly when the** | | | |

| | | | | |
|---|---|---|---|---|
| 5 | **fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.**<br><br>Monitor the fuel pressure gauge for 1 minute.Does the fuel pressure drop more than the specified value? | 34 kPa (5 psi) | Go to **Fuel System Diagnosis** | Go to **Step 6** |
| **6** | **NOTE:**<br>**Do Not repeat any portion of this test before running the engine in order to prevent the engine from flooding.**<br><br>**IMPORTANT:**<br>**Refer to the illustration in the supporting text when performing the following steps.**<br><br>1. Connect the **J 39021** Fuel Injector Coil and Balance Tester and the **J 39021-380** Fuel Injector Test Harness to a fuel injector.<br>2. Set the amperage supply selector switch on the fuel injector tester to the Balance Test 0.5-2.5 amp position.<br>3. Command the fuel pump ON and OFF with a scan tool.<br><br>**IMPORTANT:**<br>**Record the fuel pressure value immediately after the fuel injector stops pulsing. The fuel pressure may rise after the fuel injector stops pulsing. Do not record the higher fuel pressure value.**<br><br>4. Record the fuel pressure indicated by the fuel pressure gauge after the fuel pressure stabilizes. This is the first pressure reading.<br>5. Energize the fuel injector by depressing the Push to Start Test button on the fuel injector tester.<br>6. Record the fuel pressure indicated by the fuel pressure gauge. This is the second fuel pressure reading.<br>7. Repeat steps 1-6 for each fuel injector.<br>8. Subtract the second pressure reading from the first pressure reading for one fuel injector. The result is the pressure drop | 10 kPa (1.5 psi) | | |

| | | | | |
|---|---|---|---|---|
| | value.<br>9. Obtain a pressure drop value for each fuel injector.<br>10. Add all of the individual pressure drop values. This is the total pressure drop.<br>11. Divide the total pressure drop by the number of fuel injectors. This is the average pressure drop.<br><br>Does any fuel injector have a pressure drop value that is more than the average pressure drop or less than the average pressure drop by the specified value? | | Go to **Step 7** | Go to **Symptoms - Engine Controls** |
| 7 | Perform the **Fuel Injector Cleaning Procedure** . Did you complete the procedure? | - | Go to **Step 8** | - |
| 8 | Operate the vehicle in order to verify the repair. Does a driveability condition still exist? | - | Go to **Symptoms - Engine Controls** | System OK |

## FUEL INJECTOR BALANCE TEST WITH TECH 2

#### Description

The scan tool is first used to energize the fuel pump. The scan tool is then used to pulse each injector for a precise amount of time, allowing a measured amount of fuel into the manifold. This causes a drop in system fuel pressure that can be recorded and used to compare the flow through each injector.

**Fuel Injector Balance Test Example (Typical)**

| Cylinder | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1st Reading | 296 kPa (43 psi) | 296 kPa (43 psi) | 296 kPa (43 psi) | 296 kPa (43 psi) |
| 2nd Reading | 131 kPa (19 psi) | 117 kPa (17 psi) | 124 kPa (18 psi) | 145 kPa (21 psi) |
| Amount of Drop | 165 kPa (24 psi) | 179 kPa (26 psi) | 172 kPa (25 psi) | 151 kPa (22 psi) |
| Average Range: 156-176 kPa (22.5-25.5 psi) | Injector OK | Replace fuel injector - too much fuel pressure drop | Injector OK | Replace fuel injector - too little fuel pressure drop |

#### Test Description

The numbers below refer to the step numbers on the diagnostic table.

**5:** If the pressure drop value for each fuel injector is within 10 kPa (1.5 psi) of the average pressure drop value, the fuel injectors are flowing properly. Calculate the pressure drop value for each fuel injector by

subtracting the second pressure reading from the first pressure reading.

**Fuel Injector Balance Test with Tech 2**

| Step | Action | Values | Yes | No |
|---|---|---|---|---|
| **Schematic Reference:Engine Controls Schematics**<br>**Connector End View Reference:Engine Controls Connector End Views** or **Powertrain Control Module (PCM) Connector End Views** | | | | |
| 1 | Did you perform the Diagnostic System Check - Engine Controls? | - | Go to **Step 2** | Go to **Diagnostic System Check - Engine Controls** |
| 2 | Did you perform the Fuel Injector Coil Test? | - | Go to **Step 3** | Go to **Fuel Injector Coil Test** |
| 3 | **IMPORTANT:**<br>**Do not perform this test if the engine coolant temperature (ECT) is above 94°C (201°F).**<br><br>**IMPORTANT:**<br>**Verify there is adequate fuel in the fuel tank before proceeding with this diagnostic.**<br><br>1. Turn OFF the ignition.<br>2. Turn OFF all accessories.<br>3. Install the fuel pressure gauge. Refer to **Fuel Pressure Gauge Installation and Removal** .<br>4. Turn ON the ignition, with the engine OFF.<br>5. Command the fuel pump ON with a scan tool.<br><br>**IMPORTANT:**<br>• **You may need to command the fuel pump ON a few times in order to obtain the highest possible fuel pressure.**<br>• **Do not start the engine.**<br><br>6. Observe the fuel pressure gauge, with the fuel pump commanded ON.<br><br>Is the fuel pressure within the specified value? | 385-425 kPa (55-62 psi) VIN: (V, T, U) Gasoline<br>335-375 kPa (48-54 psi) VIN: Z Ethanol | Go to **Step 4** | Go to **Fuel System Diagnosis** |
| | **IMPORTANT:** | | | |

| | | | | |
|---|---|---|---|---|
| 4 | **The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.**<br><br>Observe the fuel pressure gauge for 1 minute.Does the fuel pressure drop more than the specified value? | 34 kPa (5 psi) | Go to **Fuel System Diagnosis** | Go to **Step 5** |
| **5** | **NOTE:**<br>**Refer to Fuel Injector Balance Test Notice in Cautions and Notices.**<br><br>1. Select the Fuel Injector Balance Test function with a scan tool.<br>2. Select an injector to be tested.<br>3. Press Enter. This will prime the fuel system.<br><br>**IMPORTANT:**<br>**Record the fuel pressure value immediately after the fuel injector stops pulsing. The fuel pressure may rise after the fuel injector stops pulsing. Do not record the higher fuel pressure value.**<br><br>4. Record the fuel pressure indicated by the fuel pressure gauge after the fuel pressure stabilizes. This is the 1st pressure reading.<br>5. Energize the fuel injector by depressing the Pulse Injector button on the scan tool. This will energize the injector and decrease the fuel pressure.<br>6. Record the fuel pressure indicated by the fuel pressure gauge after the fuel injector has stopped pulsing. This is the 2nd pressure reading.<br>7. Press Enter again to bring you back to the Select Injector screen.<br>8. Repeat for each fuel injector.<br>9. Subtract the 2nd pressure reading from the 1st pressure reading for one fuel injector. The result is the pressure drop value.<br>10. Obtain a pressure drop value for each fuel injector. | 10 kPa (1.5 psi) | | |

| | | | | |
|---|---|---|---|---|
| | 11. Add all of the individual pressure drop values. This is the total pressure drop.<br>12. Divide the total pressure drop by the number of fuel injectors. This is the average pressure drop.<br><br>Does any fuel injector have a pressure drop value that is either higher than the average pressure drop or lower than the average pressure drop by the specified value? | | Go to **Step 6** | Go to **Symptoms - Engine Controls** |
| 6 | Perform the **Fuel Injector Cleaning Procedure** . Did you complete the procedure? | - | Go to **Step 7** | - |
| 7 | Operate the vehicle in order to verify the repair. Does a driveability condition still exist? | - | Go to **Symptoms - Engine Controls** | System OK |

## FUEL TANK LEAK TEST

### Description

The fuel tank leak test is used to locate any fuel or fuel vapor escaping the fuel tank area. Fuel vapors escaping above the fuel level will be detected when the evaporative emission (EVAP) diagnostics complete one test cycle. The malfunction indicator lamp (MIL) will illuminate after the EVAP diagnostics have failed two test cycles.

### Diagnostic Aids

- Operate the vehicle under the condition of the customers concern. Under high temperature conditions fuel vapors may increase to the point of EVAP canister vapor saturation. Fuel vapors would then be released into the atmosphere. Once the engine is running and EVAP purge is enabled, all fuel vapor release would be eliminated.
- Movement of the EVAP pipes or fuel pipes may help find an intermittent condition.
- If the fuel level is low, a leak may not be evident.

### Test Description

The numbers below refer to the step numbers on the diagnostic table.

**4:** This step tests for fuel leaks below the fuel tank fuel level.

**5:** This step tests for fuel vapors escaping above the fuel level in the fuel tank.

**Fuel Tank Leak Test**

| Step | Action | Yes | No |
|---|---|---|---|
| | Did you perform the Diagnostic System Check - Engine Controls? | | Go to |

| | | | |
|---|---|---|---|
| 1 | | Go to **Step 2** | **Diagnostic System Check - Engine Controls** |
| 2 | **CAUTION:**<br>**Gasoline or gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.**<br>1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.<br>2. Inspect the fuel tank and fuel pipes for damage or external leaks.<br>Did you find fuel leaking from the fuel tank? | Go to **Step 6** | Go to **Step 3** |
| 3 | 1. Turn ON the ignition, with the engine OFF.<br>2. Command the fuel pump relay ON with a scan tool.<br>3. Inspect for fuel leaking from the fuel pipes.<br>Did fuel leak from the fuel pipes? | Go to **Step 7** | Go to **Step 4** |
| **4** | 1. Turn OFF the ignition.<br>2. Install the **J 41413-200** Evaporative Emissions System Tester (EEST) and the J 41415-40 Fuel Tank Cap Adaptor or the GE-41415-50 Interrupted Thread Fuel Tank Cap Adapter.<br>3. Test for a fuel tank leak referring to the J 41413-210 Operation Manual.<br>**IMPORTANT:**<br>**If the floating indicator registers any flow after stabilizing, a leak is evident.**<br>4. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.<br>5. Inspect for a fuel leak while the system is under pressure.<br>Did fuel leak from the fuel tank? | Go to **Step 6** | Go to **Step 5** |
| | 1. Using the **J 41413-200** and the J 41413-210 Operation Manual, introduce smoke into the evaporative emission (EVAP) system.<br>**IMPORTANT:**<br>**It may be necessary to partially lower the fuel tank. Refer to Fuel Tank Replacement .** | | |

| | | | |
|---|---|---|---|
| **5** | 2. Inspect for leaks in any of the following locations:<br>• The fuel tank, fill limiter vent valve, pressure relief valve, and the grade vent valves-Refer to **Fuel Tank Replacement** .<br>• The fuel sender housing and the fuel sender seal - Refer to **Fuel Sender Assembly Replacement** .<br>• The fuel tank pressure (FTP) sensor seal - Refer to **Fuel Tank Pressure Sensor Replacement** .<br>• The EVAP vapor pipes - Refer to **Evaporative Emission (EVAP) System Hoses/Pipes Replacement (Engine Compartment EVAP Pipe)** or **Evaporative Emission (EVAP) System Hoses/Pipes Replacement (Chassis EVAP Pipe)** or **Evaporative Emission (EVAP) System Hoses/Pipes Replacement (EVAP Vent Pipe)** or **Evaporative Emission (EVAP) System Hoses/Pipes Replacement (Rear EVAP Fuel Tank Pipe)** and **Evaporative Emission (EVAP) Canister Replacement** .<br>• The fuel fill pipe and hose - Refer to **Filler Tube Replacement** .<br>Did you find and correct the condition? | Go to **Step 8** | Go to Diagnostic Aids |
| 6 | Replace the fuel tank. Refer to **Fuel Tank Replacement** .<br>Did you complete the repair? | Go to **Step 8** | - |
| 7 | Replace the leaking fuel pipe. Refer to **Fuel Hose/Pipes Assembly Replacement** .<br>Did you complete the replacement? | Go to **Step 8** | - |
| 8 | Operate the system in order to verify the repair.<br>Did you correct the condition? | System OK | Go to **Step 2** |

## ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS (WITHOUT SPECIAL TOOL AND E85)

**Description**

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system, and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust, or deterioration.

Alcohol concentrations of 10 percent or greater in fuel can be detrimental to fuel system components. Alcohol contamination may cause fuel system corrosion, deterioration of rubber components, and subsequent fuel filter restriction. Some types of alcohol are more detrimental to fuel system components than others. Ethanol is commonly used in gasoline, but in concentrations of no more than 10 percent. Some fuels, such as E85, contain a very high percentage of ethanol. Fuel with more than 10 percent ethanol may cause driveability conditions such as hesitation, lack or power, stalling, or no start.

**Alcohol in Fuel Testing Procedure**

The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear. If alcohol contamination is suspected then use the following procedure to test the fuel quality.

1. Using a 100 ml specified cylinder with 1 ml graduation marks, fill the cylinder with fuel to the 90 ml mark.
2. Add 10 ml of water in order to bring the total fluid volume to 100 ml and install a stopper.
3. Shake the cylinder vigorously for 10-15 seconds.
4. Carefully loosen the stopper in order to release the pressure.
5. Re-install the stopper and shake the cylinder vigorously again for 10-15 seconds.
6. Put the cylinder on a level surface for approximately 5 minutes in order to allow adequate liquid separation.

If alcohol is present in the fuel, the volume of the lower layer, which would now contain both alcohol and water, will be more than 10 ml. For example, if the volume of the lower layer is increased to 15 ml, this indicates at least 5 percent alcohol in the fuel. The actual amount of alcohol may be somewhat more because this procedure does not extract all of the alcohol from the fuel.

#### Particulate Contaminants in Fuel Testing Procedure

The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear. If the sample appears cloudy, or contaminated with water, as indicated by a water layer at the bottom of the sample, use the following procedure to diagnose the fuel.

1. Using an approved fuel container, draw approximately 0.5 liter of fuel.
2. Place the cylinder on a level surface for approximately 5 minutes in order to allow settling of the particulate contamination.

Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles. If particles are found clean the entire fuel system thoroughly. Refer to **Fuel System Cleaning** .

## ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS (WITH SPECIAL TOOL)

#### Description

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system, and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Ethanol concentrations of greater than 10 percent in non-blended gasoline, or greater than 85 percent with E85 blended gasoline for flexible fuel applications, can cause driveability conditions and may contribute to fuel system deterioration. Excessive ethanol concentrations can result in driveability conditions such as hesitation, lack of power, stalling, or a no start, and may contribute to fuel system corrosion, deterioration of fuel system components, and a restricted fuel filter.

**Test Procedure**

1. Test the fuel composition using **J 44175** Fuel Composition Tester and J 44175-3 Instruction Manual.
2. If water appears in the fuel sample, perform the following steps:
    1. Clean the fuel system. Refer to **Fuel System Cleaning** .
    2. Replace the fuel filter if the vehicle is equipped with a serviceable fuel filter.
3. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample. Refer to the examples in the Fuel Composition Test Examples table.
4. If the non-blended gasoline fuel sample contains more than 15 percent ethanol, or if the E85 blended gasoline fuel sample contains more than 85 percent ethanol, add fresh, regular gasoline to the vehicle's fuel tank.
5. Test the fuel composition.
6. If additional testing indicates that the ethanol percentage is still more above 15 percent for a non-blended gasoline sample, drain and replace the vehicle's fuel. Refer to **Fuel System Cleaning** . If additional testing indicates that the E85 blended gasoline sample is still above 85 percent, continue adding fresh, regular gasoline until the ethanol content is 85 percent or less.

**Fuel Composition Test Examples**

| - | Frequency (Hz) | Subtract 50 | Ethanol Percent |
|---|---|---|---|
| Example A | 50 Hz | -50 | 0 |
| Example B | 65 Hz | -50 | 15 |
| Example C | 129 Hz | -50 | 79 |
| Example D | 135 Hz | -50 | 85 |

## ELECTRONIC IGNITION (EI) SYSTEM DIAGNOSIS

**Circuit Description**

The electronic ignition system uses an individual ignition coil for each cylinder. The powertrain control module (PCM) controls the ignition operation through eight individual ignition control (IC) circuits. Each bank of four ignition coils is connected to the PCM, power, or ground by the following circuits:

- Low reference
- Chassis ground
- Ignition 1 voltage
- The appropriate IC circuit

The PCM triggers an ignition coil by grounding the appropriate IC circuit using information from the crankshaft position (CKP) and camshaft position (CMP) sensors.

**Diagnostic Aids**

**IMPORTANT: A missing CMP sensor signal may cause a long crank condition.**

**The CKP signal must be available for the engine to start. The CMP signal is not needed to start and operate the engine. The PCM can determine when a cylinder is on either the firing or exhaust stroke by the 24X signal.**
**Remove any debris from the PCM connector surfaces before servicing the PCM. Inspect the PCM connector gaskets when diagnosing or replacing the PCM. Ensure that the gaskets are installed correctly. The gaskets prevent water intrusion into the PCM.**

For an intermittent condition, refer to **Intermittent Conditions** .

**Test Description**

The numbers below refer to the step numbers on the diagnostic table.

**5:** Monitoring the misfire current counters determines if a fault is present.

**12:** A good indication that the fuse is open is all off the misfire current counters are incrementing on one side of the engine. Inspect the ignition positive voltage circuit for a grounded circuit. If the fuse is open and the ignition coil circuits are OK, inspect the injector circuits for being grounded.

**Electronic Ignition (EI) System Diagnosis**

| Step | Action | Value (s) | Yes | No |
|---|---|---|---|---|
| **Schematic Reference:Engine Controls Schematics**<br>**Connector End View Reference:Engine Controls Connector End Views** or **Powertrain Control Module (PCM) Connector End Views** | | | | |
| 1 | Did you perform the Diagnostic System Check - Engine Controls? | - | Go to **Step 2** | Go to **Diagnostic System Check - Engine Controls** |
| 2 | Attempt to start the engine.<br>Does the engine start and run? | - | Go to **Step 5** | Go to **Step 3** |
| 3 | 1. Observe the Engine Speed parameter with a scan tool.<br>2. Crank the engine.<br><br>Does the scan tool indicate RPM is present? | - | Go to **Step 7** | Go to **Step 4** |
| 4 | Is DTC P0335, P0336, or P0351-P0358 also set? | - | Go to **Diagnostic Trouble Code (DTC) List** | Go to **Step 16** |
| **5** | 1. Idle the engine.<br>2. Observe the misfire current counters on the scan tool.<br><br>Does the scan tool display any misfire current counters incrementing? | - | Go to **Step 6** | Go to Diagnostic Aids |

| | | | | |
|---|---|---|---|---|
| 6 | Do the misfire current counters increment for most cylinders on one bank of the engine? | - | Go to **Step 12** | Go to **Step 7** |
| 7 | 1. Inspect the spark plug wire for open circuits, cracks, or improper seating of terminals at the spark plug or coil before proceeding with test. Refer to **Spark Plug Wire Inspection** .<br>2. Inspect for spark at the plug with the **J 26792** Spark Tester or equivalent while cranking. A few sparks, then nothing is considered no spark.<br><br>Is adequate spark present? | - | Go to **Step 33** | Go to **Step 8** |
| 8 | Measure the spark plug wire resistance. Refer to **Spark Plug Wire Inspection** .<br>Is the resistance more than the specified value? | 1,000 ohm/ft | Go to **Step 32** | Go to **Step 9** |
| 9 | 1. Turn OFF the ignition.<br>2. Disconnect the inoperative ignition coil.<br>3. Turn ON the ignition, with the engine OFF.<br>4. Probe the ignition 1 voltage circuit of the ignition coil with a test lamp connected to a good ground. Refer to **Probing Electrical Connectors** in Wiring Systems.<br><br>Does the test lamp illuminate? | - | Go to **Step 10** | Go to **Step 13** |
| 10 | Probe the ignition 1 voltage circuit at the ignition coil with a test lamp connected to the ground circuit of the ignition coil. Refer to **Probing Electrical Connectors** in Wiring Systems.<br>Does the test lamp illuminate? | - | Go to **Step 11** | Go to **Step 14** |
| 11 | Probe the ignition 1 voltage circuit at the ignition coil with a test lamp connected to the low reference circuit of the ignition coil. Refer to **Probing Electrical Connectors** in Wiring Systems.<br>Does the test lamp illuminate? | - | Go to **Step 20** | Go to **Step 15** |
| **12** | Inspect for an open INJ 1 or INJ 2 fuse.<br>Is the fuse open? | - | Go to **Step 29** | Go to **Step 23** |
| 13 | 1. Disconnect the main ignition coil 8-way connector.<br>2. Probe the ignition 1 voltage circuit at the ignition coil main 8-way connector using the test lamp connected to battery ground. Refer to **Probing Electrical Connectors** in Wiring Systems. | - | | |

| | | | | |
|---|---|---|---|---|
| | Does the test lamp illuminate? | | Go to **Step 24** | Go to **Step 23** |
| 14 | 1. Disconnect the main ignition coil 8-way connector.<br>2. Probe the ignition 1 voltage circuit on the harness side with a test lamp connected to the ground circuit of the ignition coil. Refer to **Probing Electrical Connectors** in Wiring Systems.<br><br>Does the test lamp illuminate? | - | Go to **Step 18** | Go to **Step 26** |
| 15 | 1. Disconnect the main ignition coil 8-way connector.<br>2. Probe the ignition 1 voltage circuit on the harness side with a test lamp connected to the low reference circuit of the ignition coil. Refer to **Probing Electrical Connectors** in Wiring Systems.<br><br>Does the test lamp illuminate? | - | Go to **Step 19** | Go to **Step 28** |
| 16 | 1. Turn ON the ignition, with the engine OFF.<br>2. Disconnect the crankshaft position (CKP) sensor.<br>3. Measure the voltage from the CKP sensor 12-volt reference circuit and a good ground with the DMM.<br>4. Compare the measured voltage with the system voltage.<br><br>Is the difference in the voltage more than the specified value? | 0.5 V | Go to **Step 17** | Go to **Step 30** |
| 17 | Test for a short to ground in the CKP 12-volt reference circuit or the camshaft position (CMP) sensor 12-volt reference circuit. Refer to **Circuit Testing** and **Wiring Repairs** in Wiring Systems.<br>Did you find and correct the condition? | - | Go to **Step 35** | Go to **Step 22** |
| 18 | Test for an intermittent and for a poor connection at the ignition coil 8-way connector. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** in Wiring Systems.<br>Did you find and correct the condition? | - | Go to **Step 35** | Go to **Step 25** |
| | Test for an intermittent and for a poor connection at the ignition coil 8-way connector. Refer to **Testing for Intermittent Conditions and Poor** | | | |

| | | | | |
|---|---|---|---|---|
| 19 | **Connections** and **Connector Repairs** in Wiring Systems.<br>Did you find and correct the condition? | - | Go to **Step 35** | Go to **Step 27** |
| 20 | Test for an intermittent and for a poor connection at the ignition coil. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** in Wiring Systems.<br>Did you find and correct the condition? | - | Go to **Step 35** | Go to **Step 31** |
| 21 | Test for an intermittent and for a poor connection at the CKP sensor. Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** in Wiring Systems.<br>Did you find and correct the condition? | - | Go to **Step 35** | Go to **Step 30** |
| 22 | Test for an intermittent and for a poor connection at the powertrain control module (PCM). Refer to **Testing for Intermittent Conditions and Poor Connections** and **Connector Repairs** in Wiring Systems.<br>Did you find and correct the condition? | - | Go to **Step 35** | Go to **Step 34** |
| 23 | Repair the open or high resistance in the ignition 1 voltage circuit between the fuse block and the splice. Refer to **Wiring Repairs** in Wiring Systems.<br>Did you complete the repair? | - | Go to **Step 35** | - |
| 24 | Repair the open or high resistance in the ignition 1 voltage circuit between the splice and the ignition coil connector. Refer to **Wiring Repairs** in Wiring Systems.<br>Did you complete the repair? | - | Go to **Step 35** | - |
| 25 | Repair the open in the ground circuit between the main 8-way connector and the ignition coil. Refer to **Wiring Repairs** in Wiring Systems.<br>Did you complete the repair? | - | Go to **Step 35** | - |
| 26 | Repair the open in the ground circuit. Refer to **Wiring Repairs** in Wiring Systems.<br>Did you complete the repair? | - | Go to **Step 35** | - |
| 27 | Repair the open in the low reference circuit between the main 8-way connector and the ignition coil. Refer to **Wiring Repairs** in Wiring Systems.<br>Did you complete the repair? | - | Go to **Step 35** | - |
| 28 | Repair the open in the low reference circuit between the PCM and the splice. Refer to **Wiring Repairs** in Wiring Systems.<br>Did you complete the repair? | - | Go to **Step 35** | - |
| | 1. Repair the ignition 1 voltage for a short to ground. Refer to **Wiring Repairs** in Wiring | | | |

| | | | | |
|---|---|---|---|---|
| 29 | Systems.<br>2. Replace the fuse.<br><br>Did you complete the repair? | - | Go to **Step 35** | - |
| 30 | Replace the CKP sensor. Refer to **Crankshaft Position (CKP) Sensor Replacement** .<br>Did you complete the replacement? | - | Go to **Step 35** | - |
| 31 | Replace the ignition coil. Refer to **Ignition Coil(s) Replacement** .<br>Did you complete the replacement? | - | Go to **Step 35** | - |
| 32 | Replace the spark plug wire. Refer to **Spark Plug Wire Replacement** .<br>Did you complete the replacement? | - | Go to **Step 35** | - |
| 33 | Replace the spark plug. Refer to **Spark Plug Replacement** .<br>Did you complete the replacement? | - | Go to **Step 35** | - |
| 34 | Replace the PCM. Refer to **Powertrain Control Module (PCM) Replacement** .<br>Did you complete the replacement? | - | Go to **Step 35** | - |
| 35 | Attempt to start the engine.<br>Does the engine start and continue to run? | - | Go to **Step 36** | Go to **Step 3** |
| 36 | 1. Clear the DTCs with a scan tool.<br>2. Turn OFF the engine for 30 seconds.<br>3. Start the engine.<br>4. Allow the engine to reach operating temperature.<br><br>Are there any DTCs that have not been diagnosed? | - | Go to **Diagnostic Trouble Code (DTC) List** | System OK |

## INSPECTION/MAINTENANCE (I/M) SYSTEM CHECK

#### Description

Several states require that a vehicle pass on-board diagnostic (OBD) system tests and the inspection/maintenance (I/M) emission inspection in order to renew license plates. This is accomplished by viewing the I/M System Status display on a scan tool. Using a scan tool, the technician can observe the I/M System Status in order to verify that the vehicle meets the criteria that comply with the local area requirements.

#### Conditions for Updating the I/M System Status

Each system monitor requires at least one, and sometimes several diagnostic tests. The result of each test is reported by a diagnostic trouble code (DTC). A system monitor is complete when either all of the DTCs comprising the monitor have Run and Passed, or when any one of the DTCs comprising the monitor has illuminated the malfunction indicator lamp (MIL). Once the system monitor is complete, the I/M System Status

display will indicate YES in the Completed column.

For example, when the HO2S Heater Status indicates YES, either all of the oxygen sensor heater tests have passed or one of the tests has illuminated the MIL. If the vehicle has four heated oxygen sensors, either all four heater circuit tests have passed or one of the heater circuit tests has illuminated the MIL. The I/M System Status will indicate NO under the Completed column when any of the required tests for that system have not run. The following is a list of conditions that would set the I/M System Status indicator to NO:

- The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the tests.
- The battery has been disconnected or discharged below operating voltage.
- The control module power or ground has been interrupted.
- The control module has been reprogrammed.
- The control module DTCs have been cleared.

**Monitored Emission Control Systems**

The OBD II System monitors all emission control systems that are on-board. Not all vehicles have a full complement of emission control systems. For example, a vehicle may not be equipped with secondary air injection (AIR) or exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following:

- The air conditioning system
- The catalytic converter efficiency
- Comprehensive component monitoring-Emission related inputs and outputs
- The evaporative emissions (EVAP) system
- The EGR System
- The fuel delivery system
- Heated catalyst monitoring
- Misfire monitoring
- The oxygen sensor system (O2S or HO2S)
- The oxygen sensor heater system (HO2S heater)
- The AIR system

For the specific DTCs required for each system, refer to **Inspection/Maintenance (I/M) System DTC Table** . Systems such as fuel delivery, misfire, and comprehensive components may not be listed in a system status list. These tests run continuously and do not require an I/M System Status indicator.

**Inspection/Maintenance (I/M) System Check**

| Step | Action | Value (s) | Yes | No |
|---|---|---|---|---|
| | 1. Perform **Diagnostic System Check - Engine Controls** . | | | |

| | | | | |
|---|---|---|---|---|
| 1 | **IMPORTANT:**<br>**Many DTC related repairs will instruct the technician to clear the DTC information. This procedure will reset ALL of the I/M System Status indicators to NO, and require performing the I/M Complete System Set Procedure.**<br>2. Repair any DTCs or driveability concerns that would prevent the I/M System Status tests from completing.<br>Did you find and repair a DTC or driveability concern? | - | Go to **Step 3** | Go to **Step 2** |
| 2 | 1. Review any service bulletins for software updates that may prevent inspection/maintenance (I/M) readiness.<br>2. Perform any reprogramming or repairs indicated by the service bulletins.<br>Was a reprogramming or repair service required? | - | Go to **Inspection/Maintenance (I/M) Complete System Set Procedure** | Go to **Step 3** |
| 3 | Observe the I/M System Status display with a scan tool.<br>Is more than one test indicating a NO status? | - | Go to **Inspection/Maintenance (I/M) Complete System Set Procedure** | Go to the I/M System Set Procedure for the indicated systems that have not updated |

## INSPECTION/MAINTENANCE (I/M) COMPLETE SYSTEM SET PROCEDURE

**Description**

The purpose of the inspection maintenance (I/M) Complete System Set Procedure is to satisfy the enable criteria necessary to execute all of the I/M readiness diagnostics, and to complete the trips for those particular diagnostics. When all diagnostic tests are completed, the I/M System Status indicators are set to YES. Perform this test when more than one or all of the I/M System Status indicators are set to NO.

**Conditions for Running**

### Cold Start

- The barometric pressure (BARO) is more than 75 kPa.

- The engine coolant temperature (ECT) is between 4-30°C (39-86°F).
- The intake air temperature (IAT) is between 4-30°C (39-86°F).
- The difference between the IAT and the ECT is 8°C (14°F) or less.
- The battery voltage is between 10-18 volts.
- The fuel level is between 15-85 percent.

**Diagnostic Aids**

Rough road conditions may prevent some of the tests from running. Extreme high or low ambient temperatures may prevent tests such as for the heated oxygen sensor (HO2S) heater and the evaporative emission (EVAP) system from initiating. If a step is interrupted before completion, perform the remaining portion of the set procedures. Any portion of the set procedure that requires the engine at operating temperature may be repeated. This allows most of the diagnostics to run and the remaining tests can be performed using the individual System Set Procedures.

The scan tool can be used in order to monitor each of the I/M System Status indicators during the I/M Complete System Set Procedure. When all of the indicators for a test step have updated to YES, testing can move on to the next step even if the remaining portion of the test is not complete. For example, step 3 is designed to run the EVAP, AIR, and HO2S tests. The procedure instructs the technician to operate the vehicle in the enable conditions for 6 minutes. If all 3 tests have updated to YES within 4 minutes, you do not need to continue with the enable conditions and testing can advance to the next step.

**Test Description**

The numbers below refer to the step numbers on the diagnostic table.

**2:** This step is to run the HO2S heater tests and initiate the EVAP System Test. Preprogramming the scan tool will reduce the amount of time the oxygen sensor heaters operate while verifying the enable criteria.

**3:** This step is to run the EVAP, the AIR and the oxygen sensor tests. The EVAP test begins once the engine coolant reaches a calibrated temperature. The AIR test, if equipped, begins shortly after Closed Loop and the indicated speed is achieved. The oxygen sensor tests begin once the engine is at operating temperature, in Closed Loop Fuel Control, and a calibrated amount of time has elapsed.

**4:** This step is to run the Catalyst Tests. This test runs during the idle period immediately following a cruise period that meets a minimum calibrated RPM and time period.

**Inspection/Maintenance (I/M) Complete System Set Procedure**

| Step | Action | Value (s) | Yes | No |
|---|---|---|---|---|
| **CAUTION:** **Refer to Road Test Caution in Cautions and Notices.** | | | | |
| 1 | Did you perform the Inspection/Maintenance (I/M) System Check? | - | Go to **Step 2** | Go to **Inspection/Maintenance (I/M) System Check** |
| | **IMPORTANT:** | | | |

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| **2** | **Whenever the ignition is turned ON, ignition positive voltage is supplied to the heated oxygen sensor (HO2S) heaters. After verifying the enable criteria, turn OFF the ignition for approximately 5 minutes in order to allow the sensors to cool before continuing with the test. Once the engine is started, DO NOT turn the engine OFF for the remaining portion of the set procedure.**<br>1. Preprogram the scan tool with the vehicle information before the ignition is turned ON.<br>2. Ensure that the vehicle is within the Conditions for Running specified in the supporting text.<br>3. Turn OFF all of the accessories, including the A/C, and blower fan.<br>4. Set the vehicle parking brake.<br>5. Verify the transmission is in Park for automatic transmissions and Neutral for manual transmissions.<br>6. Start the engine and allow it to idle for the specified time.<br>Is the action complete? | 2 minutes | Go to **Step 3** | - |
| **3** | In order for the next group of tests to run, the vehicle must operate in the following conditions:<br>1. Acceleration at part throttle to 90 km/h (55 mph), with this speed maintained until the engine reaches operating temperature. This may be up to 10 minutes depending on the start up coolant temperature.<br>2. Continue operation under these conditions for an additional 6 minutes.<br>Is the action complete? | - | Go to **Step 4** | - |
| | In order for the next group of tests to run, the vehicle must operate in the following conditions: | | | |

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| **4** | 1. Acceleration at part throttle to 75-89 km/h (45-55 mph) with this speed maintained for 2 minutes.<br>2. Deceleration to 0 km/h (0 mph).<br>3. Engine idling for 2 minutes while the following criteria are maintained:<br>• Service brake depressed<br>• Automatic transmission in drive<br>• Manual transmission in neutral with the clutch pedal depressed<br>Is the action complete? | - | Go to **Step 5** | - |
| 5 | Observe the I/M System Status display with a scan tool.<br>Did all of the I/M System Status indicators update to YES? | - | Go to **Step 6** | Go to the I/M System Set Procedure for the systems that have not updated |
| 6 | Observe the emission related DTC portion of the I/M System Status display with a scan tool.<br>Does the scan tool indicate any emission related DTCs set? | - | Go to **Diagnostic Trouble Code (DTC) List** | System OK |

## INSPECTION/MAINTENANCE (I/M) SYSTEM DTC TABLE

**Inspection/Maintenance (I/M) System DTC Table**

| System | DTCs Required to Set System Status to YES |
|---|---|
| Catalyst | **DTC P0420 or P0430** |
| EVAP | **DTC P0455**<br>**DTC P0442**<br>**DTC P0446**<br>**DTC P0496** |
| Oxygen Sensor | **DTC P0133 or P0153**<br>**DTC P0140 or P0160**<br>**DTC P1133 or P1153**<br>**DTC P1134 or P1154**<br>**DTC P0136 or P0156** |
| Oxygen Sensor Heater | **DTC P0135 or P0155** |

## INSPECTION/MAINTENANCE (I/M) CATALYST SYSTEM SET PROCEDURE (WITHOUT HP2)

### Description

The purpose of this test is to satisfy the enable criteria necessary to execute inspection/maintenance (I/M)

readiness diagnostics for the catalyst system. The test may be used to set the I/M System Status indicators to YES. The I/M System Status display on the scan tool provides an indication of whether the control module has completed the required tests. The I/M System Status does not indicate that the tests have passed or failed. When all of the diagnostics for a specific system have run and passed, the I/M System Status will update to YES. If a test for a specific system has failed, the I/M System Status will update to YES, indicating a determination was made even if all of the other tests for that system have not run.

**Conditions for Running**

- The engine load must be stable.
- DTCs P0420 and P0430 are not set.
- The barometric pressure is more than 74 kPa.
- The engine coolant temperature (ECT) is between 70-120°C (158-248°F).
- The engine has been running for more than 10 minutes.
- The engine is in Closed Loop fuel control.
- The battery voltage is more than 10-18 volts.
- The intake air temperature (IAT) is between -7 and +85°C (+20 and +185°F).
- The difference between the engine speed and the desired engine speed is less than 200 RPM.

**Diagnostic Aids**

The control module runs a calibrated number of catalyst tests per trip until the Catalyst System Status updates to YES. If the status does not update, the test outlined in this procedure can be repeated until the I/M System Status updates to YES.

If there is an impending failure, the system may require more time to run the diagnostic than was allotted in the set procedure. If the test does not run after numerous attempts and no DTC is set, review the appropriate scan tool data list and the service information for an indication of why the test does not complete. Some tests may abort due to changes in the conditions while the test is running. For example, changes in engine load such as a cooling fan or A/C compressor clutch turning ON may cause the test to abort.

**Inspection/Maintenance (I/M) Catalyst System Set Procedure (Without HP2)**

| Step | Action | Yes | No |
|---|---|---|---|
| 1 | Did you perform the Inspection/Maintenance (I/M) System Check? | Go to **Step 2** | Go to **Inspection/Maintenance (I/M) System Check** |
| | 1. Ensure the vehicle is within the Conditions for Running specified in the supporting text.<br>2. Turn OFF all of the accessories, e.g., A/C, blower fan, etc.<br>3. Start the engine and allow it to idle for 2 minutes. | | |

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|---|---|---|---|
| 2 | **CAUTION:**<br>**Refer to Road Test Caution in Cautions and Notices.**<br><br>**IMPORTANT:**<br>**In order for this test to run, the vehicle must operate in the following conditions:**<br>• **Acceleration at part throttle to 90 km/h (55 mph) with this speed maintained for 8 minutes**<br>• **Deceleration to 0 km/h (0 mph)**<br>• **Engine idling for 2 minutes while the following criteria is maintained:**<br>  ○ **Service brake depressed**<br>  ○ **Automatic transmission in Drive**<br><br>4. Observe the I/M System Status display with a scan tool.<br><br>Did the catalyst System Status update to YES? | Go to **Step 5** | Go to **Step 3** |
| 3 | Observe the DTC Information with a scan tool. Does the scan tool indicate any failed DTCs? | Go to **Diagnostic Trouble Code (DTC) List** | Go to **Step 4** |
| 4 | 1. Refer to the **Inspection/Maintenance (I/M) System DTC Table** to determine which DTCs are required to run in order to complete this test.<br>2. Observe the Not Ran Since Code Cleared display with a scan tool.<br>3. Determine which of the DTCs required for a YES status has not run.<br>4. Enter the DTC number in the specific DTC menu of the scan tool.<br>5. Operate the vehicle within the Conditions for Running the DTC, located in the supporting text for the diagnostic table of the DTC.<br>6. Repeat the procedure until the scan tool indicates the diagnostic test has run.<br>7. Repeat steps 4-6 for any additional required DTCs that have not run. | | |

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| | 8. Observe the I/M System Status display with a scan tool.<br><br>Did the catalyst System Status update to YES? | Go to **Step 5** | Go to Diagnostic Aids |
| 5 | Observe the emission related DTC portion of the I/M System Status display with a scan tool. Does the scan tool indicate any emission related DTCs set? | Go to **Diagnostic Trouble Code (DTC) List** | System OK |

## INSPECTION/MAINTENANCE (I/M) EVAPORATIVE EMISSION (EVAP) SYSTEM SET PROCEDURE

### Description

The purpose of this test is to satisfy the enable criteria necessary in order to execute the inspection/maintenance (I/M) readiness diagnostics for the evaporative emission (EVAP) system. The test may be used in order to set the I/M System Status indicators to YES. The I/M System Status Display on the scan tool provides an indication of when the control module has completed the required tests. The I/M System Status does not indicate that the tests have passed or failed. When all of the diagnostics for a specific system have run and passed and I/M System Status will update to YES. If a test for a specific system has failed, the I/M System Status will update to YES, indicating a determination was made, even if all of the other tests for that system have not run. Performing a visual inspection prior to running the EVAP test may prevent having to repeat the test. A failed or aborted test will require the vehicle to cool down in order to meet the enable criteria to run another test.

### Conditions for Running

- DTCs P0442, P0446, P0455, P0496 are not set.
- The barometric pressure (BARO) is more than 75 kPa.
- The fuel level is between 1/4 and 3/4.
- The battery voltage is between 10-18 volts.
- The engine coolant temperature (ECT) is between 3.75-30°C (39-86°F).
- The intake air temperature (IAT) is between 3.75-30°C (39-86°F).
- The difference between the ECT and the IAT is less than 8°C (14°F).

### Diagnostic Aids

If there is an impending failure, the system may require more time to run the diagnostic than was allotted in the set procedure. If the test does not run after numerous attempts and no DTC is set, review the appropriate scan tool data list and the service information for an indication of why the test does not complete. Some tests may abort due to changes in the conditions while the test is running. For example, changes in engine load such as cooling fan or an A/C compressor clutch turning ON may cause the test to abort.

**Inspection/Maintenance (I/M) Evaporative Emission (EVAP) System Set Procedure**

| Step | Action | Yes | No |
|---|---|---|---|
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|---|---|---|---|
| 1 | Did you perform the Inspection/Maintenance (I/M) System Check? | Go to **Step 2** | Go to **Inspection/Maintenance (I/M) System Check** |
| 2 | 1. Ensure the vehicle is within the Conditions for Running specified in the supporting text.<br>2. Turn OFF all of the accessories, including the A/C and the blower fan.<br><br>**IMPORTANT:**<br>**Once the engine is started, DO NOT turn the engine OFF for the remainder of the procedure until the test is complete.**<br><br>3. Start and idle the engine.<br><br>**CAUTION:**<br>**Refer to Road Test Caution in Cautions and Notices.**<br><br>**IMPORTANT:**<br>**In order for this test to run, the vehicle must operate in the following conditions:**<br><br>4. Acceleration at part throttle to 72 km/h (45 mph) with this speed maintained until the engine reaches operating temperature. This may be up to 8-10 minutes, depending on the startup coolant temperature.<br>5. Continue the operating conditions for an additional 3 minutes after the engine reaches the operating temperature.<br>6. Decelerate to 0 km/h (0 mph).<br>7. Idle the engine for 2 minutes.<br>8. Turn OFF the ignition for 1 hour.<br>9. After 1 hour, turn ON the ignition.<br>10. Observe the EVAP System Status with a scan tool.<br><br>Did the EVAP System Status update to YES? | Go to **Step 5** | Go to **Step 3** |
| 3 | Observe the DTC Information with a scan tool. Does the scan tool indicate any failed DTCs? | Go to **Diagnostic Trouble Code (DTC) List** | Go to **Step 4** |
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| 4 | 1. Refer to **Inspection/Maintenance (I/M) System DTC Table** to determine which DTCs are required to run in order to complete this test.<br>2. Observe the Not Ran Since Code Cleared display with a scan tool.<br>3. Determine which of the DTCs required for a YES status has not run.<br>4. Enter the DTC number in the Specific DTC menu of the scan tool.<br>5. Operate the vehicle within the Conditions for Running the DTC, located in the supporting text for the diagnostic table of the DTC.<br>6. Repeat the procedure until the scan tool indicates the diagnostic test has run.<br>7. Repeat steps 4-6 for any additional required DTCs that have not run.<br>8. Observe the I/M System Status display with a scan tool.<br><br>Did the EVAP System Status update to YES? | Go to **Step 5** | Go to Diagnostic Aids |
| 5 | Observe the Emission Related DTC portion of the I/M System Status display with a scan tool.<br>Does the scan tool indicate any Emission Related DTCs set? | Go to **Diagnostic Trouble Code (DTC) List** | System OK |

## INSPECTION/MAINTENANCE (I/M) HEATED OXYGEN SENSOR/OXYGEN SENSOR (HO2S/O2S) SYSTEM SET PROCEDURE

### Description

The purpose of this test is to satisfy the enable criteria necessary to execute inspection/maintenance (I/M) readiness diagnostics for the oxygen sensor (O2S, HO2S) system. The test may be used to set the I/M System Status to YES. The I/M System Status display on the scan tool provides an indication of whether the control module has completed the required tests. The I/M System Status does not indicate that the tests have passed or failed. When all of the diagnostics for a specific system have run and passed, the I/M System Status will update to YES. If a test for a specific system has failed, the I/M System Status will update to YES, indicating a determination was made, even if all of the other tests for that system have not run.

### Conditions for Running

- DTCs P0133, P0135, P0136, P0140, P0141, P0153, P0155, P0156, P0160, P0161, P1133, P1134, P1153, P1154 are not set.
- The fuel level is more than 10 percent.

- The engine coolant temperature (ECT) is more than 60°C (140°F).
- The engine is running in Closed Loop fuel control.
- The engine has been running for more than 3 minutes.
- The battery voltage is between 10-18 volts.
- The mass air flow (MAF) is between 20-55 grams per second.
- The engine speed is between 1,200-3,000 RPM.
- The throttle position (TP) sensor is more than 5 percent.

**Diagnostic Aids**

If there is an impending failure, the system may require more time to run the diagnostic than was allotted in the set procedure. If the test does not run after numerous attempts and no DTC is set, review the appropriate scan tool data list and the service information for an indication of why the test does not complete. Some tests may abort due to changes in the conditions while the test is running. For example, changes in engine load such as a cooling fan or A/C compressor clutch turning ON may cause the test to abort.

**Inspection/Maintenance (I/M) Heated Oxygen Sensor/Oxygen Sensor (HO2S/O2S) System Set Procedure**

| Step | Action | Yes | No |
|---|---|---|---|
| 1 | Did you perform the Inspection/Maintenance (I/M) System Check? | Go to **Step 2** | Go to **Inspection/Maintenance (I/M) System Check** |
| 2 | 1. Ensure the vehicle is within the Conditions for Running specified in the supporting text.<br>2. Turn OFF all of the accessories, e.g., A/C, blower fan, etc.<br>3. Start the engine and allow it to idle for 1 minute.<br><br>**CAUTION:**<br>**Refer to Road Test Caution in Cautions and Notices.**<br><br>**IMPORTANT:**<br>**In order for this test to run, the vehicle must operate in the following conditions:**<br><br>4. Acceleration at part throttle to 75-90 km/h (45-55 mph) with this speed maintained for 6 minutes or until the I/M System Status updates to YES.<br><br>Manual transmissions, either 5 or 6 speed, may require operation in 4th or 5th gear | | |

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|---|---|---|---|
| | respectively, in order for this test to run.<br><br>5. Review the I/M System Status display with a scan tool.<br><br>Did the HO2S/O2S System Status update to YES? | Go to **Step 5** | Go to **Step 3** |
| 3 | Observe the DTC Information with a scan tool. Does the scan tool indicate any failed DTCs? | Go to **Diagnostic Trouble Code (DTC) List** | Go to **Step 4** |
| 4 | 1. Refer to the **Inspection/Maintenance (I/M) System DTC Table** to determine which DTCs are required to run in order to complete this test.<br>2. Observe the Not Ran Since Code Cleared display with a scan tool.<br>3. Determine which of the DTCs required for a YES status has not run.<br>4. Enter the DTC number in the Specific DTC menu of the scan tool.<br>5. Operate the vehicle within the Conditions for Running the DTC, located in the supporting text for the diagnostic table of the DTC.<br>6. Repeat the procedure until the scan tool indicates the diagnostic test has run.<br>7. Repeat steps 4-6 for any additional required DTCs that have not run.<br>8. Observe the I/M System Status display with a scan tool.<br><br>Did the HO2S/O2S System Status update to YES? | Go to **Step 5** | Go to Diagnostic Aids |
| 5 | Observe the Emission Related DTC portion of the I/M System Status display with a scan tool. Does the scan tool indicate any Emission Related DTCs set? | Go to **Diagnostic Trouble Code (DTC) List** | System OK |

## INSPECTION/MAINTENANCE (I/M) HEATED OXYGEN SENSOR (HO2S) HEATER SYSTEM SET PROCEDURE

### Description

The purpose of this test is to satisfy the enable criteria necessary to execute inspection/maintenance (I/M) readiness diagnostics for the heated oxygen sensor (HO2S) heater system. The test may be used to set the I/M

System Status to YES. The I/M System Status display on the scan tool provides an indication of whether the control module has completed the required tests. The I/M System Status does not indicate that the tests have passed or failed. When all of the diagnostics for a specific system have run and passed, the I/M System Status will update to YES. If a test for a specific system has failed, the I/M System Status will update to YES, indicating a determination was made, even if all of the other tests for that system have not run.

**Conditions for Running**

- DTCs P0135, P0141, P0155, P0161 are not set.
- The engine has been running for more than 2 minutes.
- The engine coolant temperature (ECT) is more than 50°C (122°F).
- The engine speed is between 500-3,000 RPM.
- The battery voltage is between 10-18 volts.
- The mass air flow (MAF) is between 3-40 grams per second.

**Diagnostic Aids**

The HO2S Heater Tests will normally run within the 2 minutes allotted in the procedure. If there is an indeterminate condition, the test may take up to 8 minutes on some vehicles before a decision of pass or fail is made. If the test does not update to YES, it may have failed or aborted due to the loss of enabling conditions. Extremely high ambient temperatures may prevent the HO2S Heater Test from initiating.

If there is an impending failure, the system may require more time to run the diagnostic than was allotted in the set procedure. If the test does not run after numerous attempts and no DTC is set, review the appropriate scan tool data list and the service information for an indication of why the test does not complete. Some tests may abort due to changes in the conditions while the test is running. For example, changes in engine load such as a cooling fan or A/C compressor clutch turning ON may cause the test to abort.

**Inspection/Maintenance (I/M) Heated Oxygen Sensor (HO2S) Heater System Set Procedure**

| Step | Action | Value (s) | Yes | No |
|---|---|---|---|---|
| 1 | Did you perform the Inspection/Maintenance (I/M) System Check? | - | Go to **Step 2** | Go to **Inspection/Maintenance (I/M) System Check** |
| | **IMPORTANT:**<br>**Whenever the ignition is turned ON, ignition positive voltage is supplied to the heated oxygen sensor (HO2S) heaters. After verifying the enable criteria, turn OFF the ignition for approximately 5 minutes to allow the sensors to cool before continuing with the test.**<br>1. Preprogram the scan tool with the vehicle information before the ignition is turned | | | |

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| 2 | ON.<br>2. Ensure the vehicle is within the Conditions for Running as specified in the supporting text.<br>3. Set the vehicle parking brake.<br>4. Verify the transmission is in Park for automatic transmissions and Neutral for manual transmissions.<br>5. Turn OFF all of the accessories, e.g., A/C, blower fan, etc.<br>6. Start the engine and allow it to idle for the specified time or until the I/M System Status indicator updates to YES.<br><br>Did the HO2S Heater System Status update to YES? | 2 minutes | Go to **Step 5** | Go to **Step 3** |
| 3 | Observe the DTC information with a scan tool. Does the scan tool indicate any failed DTCs? | - | Go to **Diagnostic Trouble Code (DTC) List** | Go to **Step 4** |
| 4 | 1. Refer to the **Inspection/Maintenance (I/M) System DTC Table** to determine which DTCs are required to run in order to complete this test.<br>2. Observe the Not Ran Since Code Cleared display with a scan tool.<br>3. Determine which of the DTCs required for a YES status has not run.<br>4. Enter the DTC number in the Specific DTC menu of the scan tool.<br>5. Operate the vehicle within the Conditions for Running the DTC, located in the supporting text for the diagnostic table of the DTC.<br>6. Repeat the procedure until the scan tool indicates the diagnostic test has run.<br>7. Repeat steps 4-6 for any additional required DTCs that have not run.<br>8. Observe the I/M System Status display with a scan tool.<br><br>Did the HO2S Heater System Status update to | - | | |

| | | | | |
|---|---|---|---|---|
| | YES? | | Go to **Step 5** | Go to Diagnostic Aids |
| 5 | Observe the Emission Related DTC portion of the I/M System Status display with a scan tool. Does the scan tool indicate any Emission Related DTCs set? | - | Go to **Diagnostic Trouble Code (DTC) List** | System OK |